The Intersection of Mitigation and Adaptation in Climate Law and Policy

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As the world races toward a future altered by climate change, scholars and scientists are increasingly aware that efforts to mitigate the causes of climate change will not be sufficient to curb all of the consequences. Accordingly, research into adaptation has increased significantly in recent years. The scholarly community at large, and the legal community in particular, have only just begun to explore the intersection of mitigation and adaptation. In short, mitigation and adaptation are inexorably intertwined, and by exploring the intersection of the two, scholars can identify synergies, trade-offs, and other unintended consequences that may exist. As a result, policymakers and planners will be better equipped to craft effective climate policy and laws. This Article makes an important contribution to the legal literature by examining the intersection of mitigation and adaptation, and offering a framework with which decisionmakers can explore the two in tandem to produce a more reasoned and effective response to climate change.

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I. INTRODUCTION

In altering the atmospheric concentration of greenhouse gases, humankind has set in motion a series of physical processes that portend consequences for the species that range from challenging to catastrophic. Indeed, the repercussions of anthropogenic climate change are already measurable in the rise of sea levels,[1] the increase in frequency of some extreme weather events,[2] and the staggering melt of Arctic summer sea ice.[3] More worrisome, several positive climate

[1] *See Mean Sea Level Rise*, AVISO, http://www.aviso.altimetry.fr/en/data/products/ocean-indicators-products/actualitesindicateurs-des-oceansniveau-moyen-des-mersindexhtml.html (last visited Oct. 23, 2014).

[2] Dim Coumou & Stefan Rahmstorf, *A Decade of Weather Extremes*, 2 NATURE CLIMATE CHANGE 491, 494 (2012) ("Many lines of evidence . . . strongly indicate that some types of extreme event, most notably heatwaves and precipitation extremes, will greatly increase in a warming climate *and have already done so*.") (emphasis added); *see also* Simon K. Allen et al., *Summary for Policymakers*, *in* MANAGING THE RISKS OF EXTREME EVENTS AND DISASTERS TO ADVANCE CLIMATE CHANGE ADAPTATION. SPECIAL REPORT OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE 8–9 (Christopher B. Field et al. eds., 2012).

[3] *See generally Arctic Sea Ice Volume Anomaly and Trend from PIOMAS*, POLAR SCI. CTR., UNIV. OF WASH., http://psc.apl.washington.edu/wordpress/research/projects/arctic-sea-ice-volume-

feedbacks are poised to amplify the rate and magnitude of warming in the years to come.[4] Most notably, permafrost across the Arctic holds enormous amounts of carbon that, through microbial respiration, may be released to the atmosphere in the form of methane and carbon dioxide and greatly increase the impacts of climate change.[5] To prevent "tipping points" that will trigger unstoppable feedbacks like the permafrost melt, and thus avoid the worst impacts of climate change, humans must drastically reduce emissions of greenhouse gases and the destruction of carbon sinks.[6] Such reductions must begin in the very near future.[7]

Regardless of the speed and extent of anthropogenic mitigation of climate change, however, the world is committed to some degree of future warming and impacts.[8] This warming "in the pipeline" results from inertia in human and natural systems;[9] the former guarantees the release of some amount of future

anomaly/ (click on image) (last visited Oct. 25, 2014).

[4] *See* IAN ALLISON ET AL., CLIMATE CHANGE RESEARCH CENTRE, UNIV. OF NEW S. WALES, THE COPENHAGEN DIAGNOSIS, 2009: UPDATING THE WORLD ON THE LATEST CLIMATE SCIENCE 42 (2009).

[5] *See* Edward Schuur & Benjamin Abbot, *High Risk of Permafrost Thaw*, 480 NATURE 32, 32 (2011). The speed at which the permafrost will melt and emit carbon is still unknown, though some recent studies suggest the process could be happening quicker than previously thought. *See, e.g.*, Rose M. Curry et al., *Surface Exposure to Sunlight Stimulates CO_2 Release From Permafrost Soil Carbon in the Arctic*, 110 PROC. OF THE NAT'L ACADEMY OF SCI. 3429, 3432 (2013) (finding that permafrost soil exposed to sunlight may release carbon dioxide 40% more rapidly than soil in the dark); *Methane Release from Arctic Shelf May be Much Larger and Faster than Anticipated*, NATIONAL SCIENCE FOUNDATION, http://www.nsf.gov/news/news_summ.jsp?cntn_id=116532 &org=NSF&from=news (last visited Oct. 25, 2014); Gail Whiteman et al., *Climate Science: Vast Costs of Arctic Change*, 499 NATURE 401 (2013). *But see* Chris Mooney, *How Much Should You Worry About an Arctic Methane Bomb*, MOTHERJONES (Aug. 8, 2013), http://www.motherjones.com /environment/2013/08/arctic-methane-hydrate-catastrophe (quoting many climate scientists who dispute the dire findings of Whitman et al., *supra*).

[6] *See* ALLISON ET AL., *supra* note 4, at 7 ("Delay in action risks irreversible damage . . . .").

[7] *Id.* ("The turning point must come soon. . . .").

[8] *See* Richard J.T. Klein et al., *Inter-relationships Between Adaptation and Mitigation*, *in* CLIMATE CHANGE 2007: IMPACTS, ADAPTATION AND VULNERABILITY. CONTRIBUTION OF WORKING GROUP II TO THE FOURTH ASSESSMENT REPORT OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE 747 (Martin L. Parry et al. eds., 2007); *see also* Robin Kundis Craig, *"Stationarity Is Dead"—Long Live Transformation: Five Principles for Climate Change Adaptation Law*, 34 HARV. ENVTL. L. REV. 9, 14 (2010) ("[W]hat happens to socio-ecological systems over the next decades, and most likely over the next few centuries, will largely be beyond human control."); Rob Swart & Frank Raes, *Making Integration of Adaptation and Integration Work: Mainstreaming Into Sustainable Development Policies?*, 7 CLIMATE POL'Y 288, 294 (2007) ("[N]atural and human systems [will] at some point be unable to adapt.").

[9] James Hansen et al., Earth's Energy Imbalance: Confirmation and Implications, 308 SCI. 1431, 1432–34 (2005) (discussing thermal inertia that will lead to additional warming "even if atmospheric composition and other climate forcings remain fixed at today's values"); D. P. Van Vuuren et al., *Temperature Increase of 21st Century Mitigation Scenarios*, 105 PROC. OF THE NAT'L ACADEMY OF SCI. 15258, 15258 (2007). Though I use it to describe inertia in both natural and human systems, warming "in the pipeline" traditionally refers to warming caused by inertia in natural systems only. The natural inertia is the result of the planetary energy imbalance caused by

greenhouse gas emissions notwithstanding mitigation decisions,[10] while the latter ensures more warming from previously released emissions.[11] Consequently, societies must implement adaptation measures to ensure that vulnerable populations, ecosystems, and social and economic systems are sufficiently able to absorb the impacts of climate change and, hopefully, thrive thereafter.[12]

For many years, climate change literature and policy effectively ignored adaptation, as many scholars and politicians worried that focus on adaptation might stymie mitigation efforts.[13] In recent years, however, scholars have recognized the need for adaptation regardless of mitigation, and the legal and scientific literature on adaptation has expanded tremendously.[14] The literature discusses adaptation from technological, economic, policy, social, planning, and

the increased anthropogenic greenhouse gases in the atmosphere. In short, the additional gas prevents greater quantities of infrared radiation from reflecting back into space, resulting in more energy entering the system than exiting. Consequently, there is an energy imbalance on earth, and the planet will continue to warm until it radiates enough longwave energy to counterbalance the incoming solar radiation. *See generally* Kevin E. Trenberth et al., *Earth's Global Energy Budget*, 90 BULL. AM. METEOROLOGICAL SOC'Y 311 (2009).

[10] Societal inertia guarantees there will be a significant amount of greenhouse gas emissions in the future regardless of policy decisions, which will compound the inertia in natural systems and ensure future warming. Humans rely on fossil fuels to a staggering degree; they power most of our cars, our homes, our businesses, our industries, our planes, and our boats. Accordingly, moving away from fossil fuels requires tremendous political and social will. Further, transitioning from fossil fuels takes time and money and may require *increased* fossil fuel use to facilitate the transition. The practical difficulties of weaning society from fossil fuels make it extremely difficult to even slow the increase in the global rate of emissions. *See, e.g.*, Global Carbon-Dioxide Emissions Increase by 1.0 Gt in 2011 to Record High, Int'l Energy Agency (May 24, 2012) http://www.iea.org/newsroomandevents/news/2012/may/name,27216,en.html (noting a new record in global emissions despite a reduction in U.S. emissions).

[11] Rob Painting, *Search for "Missing Heat" Confirms More Global Warming "in the Pipeline,"* SKEPTICAL SCIENCE (Feb. 19, 2012), http://www.skepticalscience.com/Search-For-Missing-Heat-Confirms-More-Global-Warming-In-The-Pipeline-.html (noting that warming will increase until the planetary balance between incoming energy and outgoing heat is restored).

[12] *See* Klein et al., *supra* note 8, at 747.

[13] *See* J.B. Ruhl, *Climate Change Adaptation and the Structural Transformation of Environmental Law*, 40 ENVTL. L. 363, 365–66 (2010); *see also* Swart & Raes, *supra* note 8, at 289 ("One of the reasons that adaptation was not only treated separately but also received little attention at the beginning of the climate change negotiations was that – especially in Europe – an emphasis on adaptation was suggested in order to take away the urgency of mitigation."); Craig, *supra* note 8, at 14.

[14] *See generally, e.g.*, Ruhl, *supra* note 13; David L. Markell, *Greening the Economy Sustainably*, 1 WASH. & LEE J. ENERGY, CLIMATE, & ENV'T 41 (2010); Craig, *supra* note 8, at 9; Holly Doremus, *Adapting to Climate Change with Law that Bends Without Breaking*, 2 SAN DIEGO J. CLIMATE & ENERGY L. 45 (2010); Alejandro E. Camacho, *Adapting Governance to Climate Change: Managing Uncertainty Through a Learning Infrastructure*, 59 EMORY L. J. 1 (2009); Daniel H. Cole, *Climate Change, Adaptation, and Development*, 26 U.C.L.A. J. ENVTL. L. & POL'Y 1 (2008); CLIMATE CHANGE 2007: IMPACTS, ADAPTATION AND VULNERABILITY. CONTRIBUTION OF WORKING GROUP II TO THE FOURTH ASSESSMENT REPORT OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE (Martin L. Parry et al. eds., 2007).

legal perspectives.

While the literature on adaptation expanded in the early 2000s, scant treatment was given to the intersection, or integration, of mitigation and adaptation.[15] The two climate change responses "were framed by policy makers and scientists as complementary but disconnected approaches,"[16] and as a result, separate and distinct research on the two topics occurred.[17] This philosophical divide is known as the mitigation-adaptation dichotomy.[18] Only recently have academics and scientists begun to search for synergies and trade-offs between the two climate change responses.[19] Temporal, spatial, and stakeholder differences between the two may limit the potential for integrating mitigation and adaptation into a singular, all-encompassing model.[20] In short, adaptation and mitigation are often carried out by different actors in different places with benefits that accrue at different times;[21] accordingly, integrated solutions will not always prove beneficial or practical. Despite the possible limitations, however, it would be unwise to ignore potential opportunities to exploit synergies; moreover, viewing climate change responses through an integrated lens provides an opportunity to make reasoned decisions about trade-offs and unintended consequences caused by the intersection of mitigation and adaptation. Further research into the interactions, synergies, and trade-offs inherent in the mitigation-adaptation dichotomy is therefore necessary to develop effective climate policies and laws.[22]

The literature concerning the future of legal regimes in a climate-changed world has only begun to address the integration of mitigation and adaptation.[23] This Article thus contributes an important analytical component to the existing literature on the society's response to climate change. It first defines and discusses adaptation and mitigation in Part II. In so doing, this Part examines the philosophical and practical differences between the concepts that until recently

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[15] *See* Klein et al., *supra* note 8, at 747 (finding a "lack of both conceptual and empirical information that explicitly considers both adaptation and mitigation makes it difficult to assess the need for and potential of synergies in climate policy"); *see also* Swart & Raes, *supra* note 8, at 290.

[16] G. Robbert Biesbroek et al., *The Mitigation-Adaptation Dichotomy and the Role of Spatial Planning*, 33 HABITAT INT'L 230, 231 (2009).

[17] *See* Klein et al., *supra* note 8, at 748; *see also* Swart & Raes, *supra* note 8, at 290.

[18] Biesbroek et al., *supra* note 16, at 230.

[19] *Id.*; *see also, e.g.*, Jessica M. Ayers & Saleemul Huq, *The Value of Linking Mitigation and Adaptation: A Case Study of Bangladesh*, 43 ENVTL. MGMT. 753, 757 (2009).

[20] Swart & Raes, *supra* note 8, at 296 (noting, for example, that "capturing adaptation and mitigation in one model [at the regional and national level] makes little sense" due to spatial and temporal contrasts).

[21] *See* Richard J.T. Klein et al., *Integrating Mitigation and Adaptation Into Climate and Development Policy: Three Research Questions*, 8 ENVTL. SCIENCE & POL'Y 579, 581 (2005).

[22] Biesbroek et al., *supra* note 16, at 232.

[23] *See, e.g.*, Lesley K. McAllister, *Adaptive Mitigation in the Electric Power Sector*, 2011 B.Y.U. L. REV. 2115 (2011); Katherine A. Trisolini, *Holistic Climate Change Governance: Towards Mitigation and Adaptation Synthesis*, 85 U. COLO. L. REV. 615 (2014).

prevented an integrated analysis, and provides examples of mitigation and adaptation from substantive and policy perspectives. Part III then explores the intersection of mitigation and adaptation and discusses the ways in which the two climate change responses interact. Further, it discusses synergies, trade-offs, and other unintended consequences of adaptation on mitigation, and vice versa. Part IV argues that effective climate policy and law must be viewed through a mitigation-adaptation lens to ensure that all opportunities to address climate change and avoid unintended consequences are considered. It then describes existing proposals to alter legal frameworks in response to climate change, and examines the nascent legal literature on the intersection of mitigation and adaptation. Finally, Part V concludes by proposing a framework for incorporating the mitigation-adaptation lens into policymaking and planning. This framework provides a starting point for future research into how best to analyze mitigation and adaptation decisions in the future, and addresses some limitations that might otherwise prevent a comprehensive and effective climate change response.

II. MITIGATION AND ADAPTATION

A. Defining Mitigation and Adaptation

The Intergovernmental Panel on Climate Change defines mitigation as an "anthropogenic intervention to reduce the sources or enhance the sinks of greenhouse gases."[24] It defines adaptation as "[a]djustment[s] in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderate[] harm or exploit[] beneficial opportunities."[25] Mitigation is often framed as a proactive endeavor that addresses the sources of climate change, whereas adaptation is framed as reactive measures to the effects of climate change.[26] Proactivity and reactivity should not, however, be seen as distinguishing or preclusive features of the two approaches. Successful adaptation generally requires a proactive approach, with research and planning preceding implementation, often by many years.[27] Likewise, mitigation can be understood as reacting to past failures to curb greenhouse gas emissions and addressing the unwanted consequences of those failures. Regardless of how they are framed, both mitigation and adaptation have the same purpose of reducing the undesirable effects of climate change.[28]

[24] *See* Klein et al., *supra* note 8, at 750 (using definitions found in the Third Assessment Report of the Intergovernmental Panel on Climate Change).

[25] *See id*.

[26] Biesbroek et al., *supra* note 16, at 232.

[27] *See* Camacho, *supra* note 14, at 18–19 (discussing proactive and reactive adaptation).

[28] Swart & Raes, *supra* note 8, at 289; *see also* McAllister, *supra* note 23, at 2122 ("While the goals of mitigation and adaptation policy and the sectors they target are different in some ways, the

While both mitigation and adaptation share a common goal, there are philosophical and practical differences between the two. Most notably, temporal and spatial differences distinguish both the approach to and benefits of the two options.[29] The climate-related benefits of mitigation measures are expected to accrue many years after implementation, if at all, while the benefits of adaptation may, in some instances, be felt immediately upon implementation.[30] Mitigation measures must be nationally or internationally oriented if they are to be effective,[31] and are carried out at the local to international level.[32] Because greenhouse gases are ubiquitous and the effects of anthropogenic climate change are global, however, the benefits of mitigation should accumulate globally.[33] Adaptation measures are primarily, though not always, implemented at the local or regional level, and the effects accrue accordingly.[34] Moreover, specific adaptation measures may vary considerably based on where they are implemented. While some adaptation solutions have universal qualities and can be broadly implemented—many areas, for instance, require protection from rising seas—others must be uniquely tailored for specific geographic and socioeconomic conditions.

In addition to the spatial and temporal differences between mitigation and adaptation, disparate actors implement the two approaches, often under distinct regulatory regimes.[35] Further, mitigation involves fewer sectoral actors than adaptation, and is primarily instituted through the energy, transportation, forestry, and agricultural sectors.[36] Conversely, adaptation is implemented by myriad sectors spanning from public health and planning to tourism and

ultimate concern of both is the same: how should society respond to climate change?"). Swart and Raes query if climate policy may have developed differently "if the early definitional split between mitigation and adaptation had not occurred," and note that in "health care, both types of response are captured by a single term: prevention." Swart & Raes, *supra* note 8, at 302 n.1.

[29] Biesbroek et al., *supra* note 16, at 232.

[30] Klein et al., *supra* note 8, at 750. Ancillary benefits from mitigation—for instance, the decrease in air pollution resulting from a switch from coal-generated power to solar power—may have more immediate impact. *See id.*

[31] Biesbroek et al., *supra* note 16, at 232–33.

[32] *Id.*; Klein et al., *supra* note 21, at 581 (noting that both mitigation and adaptation may be carried out at the same regional or local level).

[33] Klein et al., *supra* note 8, at 750. Because the effects of global warming are global, but varied and not evenly distributed, the degree of benefit from mitigation may—and likely will—vary geographically.

[34] *See id.* ("Adaptation typically works on the scale of an impacted system, which is regional at best, but mostly local . . . ."); Biesbroek et al., *supra* note 16, at 232–33. *But see* McAllister, *supra* note 23, at 2121 (noting that "[a]daptation has many dimensions that will require international and national governance," and concerns large-scale issues like "providing for climate refugees and dealing with changes in agriculture production and trade").

[35] *See* Klein et al., *supra* note 21, at 581.

[36] *Id.* Klein et al. find that the energy and transportation sectors in industrialized nations, and to an increasing extent in developing nations, play a large role. *Id.* Individuals can also contribute to mitigation through conservation and efficiency choices. *See* discussion, *infra* Part B.

conservation.[37] Because the primary actors in mitigation are organized—often nationally and internationally—and closely linked to planning and policymaking,[38] employment of widespread mitigation measures may require fewer policies to implement than adaptation. On the other hand, the organized sectors involved in mitigation may be more resistant to widespread mitigation policies and—because of their political and financial clout—more able to contest policy initiatives.[39] In contrast, the sectors involved in adaptation are not inherently related and, even where organized through groups like the National Tourism Association, are dispersed practically and geographically.[40] Adaptation policies and laws will therefore affect, and must be crafted in consultation with, a vast array of interested stakeholders that have unique interests and operate under diverse regulatory regimes. Because the sectors underlying adaptation are so varied, however, organized opposition to adaptation policy is likely to be less intense than with mitigation.

Mitigation and adaptation can therefore be distinguished conceptually and practically at the temporal and spatial levels, and by the different stakeholders who carry out and are affected by the two climate change responses. Both mitigation and adaptation can be implemented, however, through a vast array of substantive measures and policy tools.

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[37] Klein et al., *supra* note 21, at 581 (finding that "the actors involved in adaptation represent a large variety of sectoral interests, including agriculture, tourism and recreation, human health, water supply, coastal management, urban planning and nature conservation"). Indeed, it is hard to think of a sector of the economy or ecology that will not need to adapt, in some way, as the consequences of climate change grow larger and direr.

[38] *Id.* For instance, the electricity generation industry in the United States is united by regulatory bodies such as the Federal Energy Regulatory Commission, and by voluntary bodies such as the North American Electric Reliability Organization. *See HISTORY OF NERC*, N. AM. ELEC. RELIABILITY COUNCIL, http://www.nerc.com/AboutNERC/Documents/History_Dec12.pdf (last visited Oct. 25, 2013).

[39] There is considerable evidence that some actors in the energy industry, particularly those reliant on fossil fuels for profit generation, have worked diligently to prevent any large-scale mitigation policies by funding a campaign of misinformation and doubt about climate science. *See, e.g.*, JAMES LAWRENCE POWELL, THE INQUISITION OF CLIMATE SCIENTISTS 110–16 (2011); JAMES HOGGAN & RICHARD LITTLEMORE, CLIMATE COVER-UP: THE CRUSADE TO DENY GLOBAL WARMING 168–205 (2009); *Covert Operations*, THE NEW YORKER, http://www.newyorker.com/reporting/2010/08/30/100830fa_fact_mayer?currentPage=1 (last visited Oct. 25, 2014) (describing the Koch brothers involvement in climate science denial); *see generally, e.g.*, 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). *But see* Klein et al., *supra* note 21, at 581 ("[I]ncentives and opportunities created by national and international climate policy have increasingly stimulated mitigation activities by the energy and forestry sectors.").

[40] To wit, the tourism interests in South Florida—and any necessary accompanying adaptation—are considerably different from those in Central Iowa or the Pacific Northwest.

B. Substantive Mitigation

Generally, mitigation refers to any effort to reduce anthropogenic emissions of greenhouse gases or withdraw greenhouse gases from the atmosphere.[41] There are a wide variety of mitigation instruments that can reduce greenhouse gas emissions.[42] To simplify, this Article addresses four broad categories of mitigation options: production of energy with less greenhouse gas emissions than traditional fossil fuels; technology to remove greenhouse gases from the atmosphere; land use, agricultural, and forest management practices that reduce greenhouse gases in the atmosphere; and conservation and efficiency. Within each of these categories are several subcategories of mitigation options, a full discussion of which is beyond the scope of this Article. Further, there is considerable overlap between the categories. Accordingly, this sub-Part discusses the four broad categories in general terms.

1. Production of Energy With Less Emissions

Energy that is primarily derived from fossil fuels and used for heat, electricity, and transport, is responsible for approximately 70% of global greenhouse gas emissions.[43] Accordingly, the primary mitigative tools available produce energy with less greenhouse gas emissions than energy produced from traditional fossil fuels.[44] These tools include renewable energy such as solar, wind, hydro, ocean, and geothermal power, which all produce substantially less emissions than power generated from fossil fuels.[45] In addition to renewable energy sources, nuclear power generates approximately the same life-cycle

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[41] *Climate Change Mitigation*, UNITED NATIONS ENV'T PROGRAMME, http://www.unep.org/climatechange/mitigation/ (last visited Oct. 25, 2014).

[42] Terry Barker et al., *Summary for Policymakers*, CLIMATE CHANGE 2007: MITIGATION. CONTRIBUTION OF WORKING GROUP III TO THE FOURTH ASSESSMENT REPORT OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE 19 (Bert Metz et al. eds.).

[43] Ralph E.H. Sims & Robert N. Schock, *Energy Supply*, CLIMATE CHANGE 2007: MITIGATION. CONTRIBUTION OF WORKING GROUP III TO THE FOURTH ASSESSMENT REPORT OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE 253 (Bert Metz et al. eds.). Fossil fuel energy accounts for almost 85% of all anthropogenic carbon dioxide emissions. *Id.* at 265.

[44] *Id.* at 265 ("If GHGs are to be reduced significantly, . . . current uses of fossil energy will have to shift toward low- and zero-carbon sources."); *see also Stabilization Wedges Introduction*, CARBON MITIGATION INITIATIVE., PRINCETON UNIV., http://cmi.princeton.edu/wedges/intro.php (last visited Oct. 25, 2014) (showing that seven of fourteen climate "stabilization wedges," which are proposed to avert the worst damages of climate change, are related to technologies that produce energy with fewer greenhouse gas emissions than traditional fossil fuels); *see also* Ottmar Edenhofer et al., *Summary for Policymakers*, *in* IPCC SPECIAL REPORT ON RENEWABLE ENERGY SOURCES AND CLIMATE CHANGE MITIGATION 24 (Ottmar Edenhofer et al. eds. 2012) ("[I]f [renewable energy] deployment is limited, mitigation costs increase and low GHG concentration stabilizations may not be achieved.").

[45] *Clean Energy*, UNION OF CONCERNED SCIENTISTS, http://www.ucsusa.org/clean_energy/ (last visited Oct. 25, 2014).

greenhouse gas emissions as renewable sources.[46] Natural gas may also provide substantial greenhouse gas savings if used to replace coal in electricity generation;[47] there is, however, debate in the scientific literature about how significant the greenhouse gas savings from natural gas are.[48]

Large-scale mitigation on a global level necessarily requires a conversion of significant portions of the energy sector to low- or no-carbon energy.[49] Unfortunately, many reduced-emissions energy sources have limitations that currently hinder widespread deployment. For example, renewable power potential is inequitably spread around the country.[50] Additionally, many of the areas with the greatest renewable energy potential are remote and not connected by transmission lines.[51] Further, intermittency poses serious problems for the widespread implementation of solar and wind power,[52] as do price considerations.[53] Nevertheless, many scholars argue that the world can achieve substantial emissions reductions by implementing existing low- and no-carbon technologies.[54]

In addition to reduced-emissions sources of energy, existing and proposed technologies can decrease emissions from energy derived from fossil fuels. Carbon capture and sequestration (or storage) (CCS), for instance, could theoretically allow for the continued burning of all fossil fuels at significantly

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[46] Sims & Schock, *supra* note 43, at 269.

[47] *Id.* at 265 ("Natural gas is the fossil fuel that produces the lowest amount of GHG per unit of energy consumed and is therefore favoured in mitigation strategies.").

[48] *Compare, e.g.*, Robert W. Howarth et al., *Venting and Leaking of Methane from Shale Gas Development: Response to Cathles et al.*, 113 CLIMATIC CHANGE 537, 537 (2012), *with* Lawrence M. Cathles et al., *A Commentary on "The Greenhouse-gas Footprint of Natural Gas in Shale Formations" by R.W. Howarth, R. Santoro, and Anthony Ingraffea*, 113 CLIMATIC CHANGE 525, 525 (2012). For more on the methane implications of natural gas, *see generally*, Adam R. Brandt et al., *Methane Leaks from North American Natural Gas Systems*, 343 SCI. 733 (2014); David T. Allen et al., *Measurements of Methane Emissions at Natural Gas Production Sites in the United States*, 110 PROC. OF THE NAT'L ACAD. OF SCI. 17768 (2013).

[49] Sims & Schock, *supra* note 43, at 265. Significant emissions reductions could theoretically be achieved without a conversion to renewable energy through any number of catastrophic population-reducing mechanisms. This Article presumes that humanity desires not only to reduce emissions significantly, but also to retain some semblance of current society.

[50] *See, e.g.*, *Solar Maps*, NAT'L RENEWABLE ENERGY LABORATORY, http://www.nrel.gov/gis/solar.html (last visited Oct. 25, 2014); *Wind Maps*, NAT'L RENEWABLE ENERGY LABORATORY, http://www.nrel.gov/gis/wind.html (last visited Oct. 25, 2014); *Geothermal Maps*, NAT'L RENEWABLE ENERGY LABORATORY, http://www.nrel.gov/gis/geothermal.html (last visited Oct. 25, 2014).

[51] Hannah Wiseman, *Expanding Regional Renewable Governance*, 35 HARV. ENVTL. L. REV. 477, 511–14 (2011) (discussing interstate and intrastate transmission challenges to renewable energy development).

[52] Sims & Schock, *supra* note 43, at 272–73.

[53] *See* William Moomaw & Francis Yamba, *Renewable Energy and Climate Change*, *in* IPCC SPECIAL REPORT ON RENEWABLE ENERGY SOURCES AND CLIMATE CHANGE MITIGATION 165 (Ottmar Edenhofer et al. eds. 2012).

[54] *Stabilization Wedges Introduction*, *supra* note 44.

reduced emissions.[55] The cost and practical difficulties of CCS thus far has limited its implementation on a large-scale.[56] More practically, better technology can increase the energy efficiency of currently existing emissions sources.[57] Similarly, advances in automobile technology often lead to vehicles with substantially higher gas mileage.[58] By increasing the energy efficiency of the existing energy and transportation industries, society can realize significant emissions reductions. If those reductions are not sufficiently significant, however, other technologies may allow for the removal of atmospheric greenhouse gases.

2. Technology to Withdraw Greenhouse Gases from the Atmosphere

Along with technologies that produce energy with fewer greenhouse gas emissions or reduce the greenhouse gas emissions of energy derived from traditional fossil fuels, there are technologies that may, in the future, allow humanity to withdraw significant greenhouse gases from the ambient atmosphere.[59] Some are like CCS, and would capture carbon dioxide and store it underground.[60] Other plans involve seeding the ocean with iron sulphate to create algae blooms that might sequester more carbon dioxide in the ocean.[61] These efforts are often defined as geoengineering,[62] a group of climate change responses that might be considered mitigation or adaptation, depending on the specific technology involved.[63] Geoengineering may even constitute a class of

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[55] *See generally* Sims & Schock, *supra* note 43, at 284–86.

[56] *Id.* at 286; *see also* R. Stuart Haszeldine, *Carbon Capture and Storage: How Green Can Black Be?*, 325 SCI. 1647, 1647 (2009) (noting the "many technological, commercial, and political hurdles" to widespread use of carbon capture and storage).

[57] *See* Barker et al., *supra* note 42, at 10 (noting improved supply and distribution efficiency as key mitigation tools).

[58] *See, e.g.*, Suzana Kahn Ribeiro & Shigeki Kobayashi, *Transport and Its Infrastructure*, *in* CLIMATE CHANGE 2007: MITIGATION. CONTRIBUTION OF WORKING GROUP III TO THE FOURTH ASSESSMENT REPORT OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE 340 (Bert Metz et al. eds.) (noting greater mileage from plug-in hybrid electric vehicles).

[59] *See, e.g.*, Gaia Vince, *Sucking CO2 from the Skies with Artificial Trees*, BBC (Oct. 4, 2012), http://www.bbc.com/future/story/20121004-fake-trees-to-clean-the-skies (noting that some scientists are "looking at ways to modulate the global temperature by removing some of this greenhouse gas from the air").

[60] *Id.*

[61] Martin Lukacs, *World's Biggest Geoengineering Experiment "Violates" UN Rules*, THE GUARDIAN (Oct. 15, 2012), http://www.guardian.co.uk/environment/2012/oct/15/pacific-iron-fertilisation-geoengineering.

[62] For more thorough discussions of geoengineering, *see, e.g.*, H. Damon Matthews & Ken Caldeira, *Transient Climate-Carbon Simulations of Planetary Geoengineering*, 104 PROC. OF THE NAT'L ACAD. OF SCI. 9949 (2007); B. Govindasamy et al., *Impact of Geoengineering Schemes on the Terrestrial Biosphere*, 29 GEOPHYSICAL RESEARCH LETTERS 2061 (2002).

[63] *See* Ken Caldeira & David W. Keith, *The Need for Climate Engineering Research*, 27 ISSUES SCI. & TECH. 57, 58 (2010). Technologies that remove carbon dioxide from the atmosphere would likely be considered mitigation, as they address the cause of climate change. *Id.* Other proposals seek

climate change responses that is distinct from both mitigation and adaptation.[64] Regardless of classification, many geoengineering options would reduce the atmospheric concentrations of greenhouse gases. Geoengineering measures are not yet well understood, and may be "extremely risky."[65] While these technologies are in nascent stages and are still subject to debate, they may nevertheless play an important role in mid- to late-century mitigation if society fails to adequately mitigate in the coming decades.[66] Further research is therefore needed on geoengineering solutions.[67]

3. Land Use, Forestry, and Agricultural Management

In addition to implementing existing and new technologies to reduce emissions or withdraw greenhouse gases from the atmosphere, societies can also change the way land is used and managed to provide further mitigative relief.[68] Reduced deforestation and increased afforestation lead to reduced carbon dioxide in the atmosphere through the protection and creation of carbon sinks.[69] Similarly, improved crop selection, reduced use of bare land, and improved water management can all enhance carbon storage.[70] Land management techniques for mitigation also extend to livestock, which accounts for approximately one-third of all anthropogenic emissions of methane.[71] Improved livestock practices could reduce those emissions significantly.[72] Land management techniques and technologies thus provide substantial mitigation

to "diminish the adverse climate effects of elevated greenhouse gas concentrations without addressing the root cause of the problem." *Id.* This second group of technologies is designed instead to reduce the resulting warming from greenhouse gas emissions globally in order to give society more time to develop a solution, and would likely be considered adaptation. For instance, some scientists propose to seed the atmosphere with sulfur aerosols, which reflect sunlight before it can be trapped by greenhouse gases. *See, e.g.*, Andrew Moseman, *How Geoengineering Works: 5 Big Plans to Stop Global Warming*, POPULAR MECHANICS (Oct. 1, 2009), http://www.popularmechanics.com/science/environment/4290084.

[64] NATIONAL CLIMATE ASSESSMENT AND DEVELOPMENT ADVISORY COMMITTEE, NCADAC DRAFT CLIMATE ASSESSMENT REPORT 958 (2012), *available at* http://ncadac.globalchange.gov/download/NCAJan11-2013-publicreviewdraft-fulldraft.pdf (draft report that will, after comment, be submitted for consideration in the Third National Climate Assessment Report).

[65] *Id.* at 1109.

[66] Caldeira & Keith, *supra* note 63, at 57–58.

[67] *Id.* at 61.

[68] Barker et al., *supra* note 42, at 14.

[69] *See id.* at 10. *But see* F.S. Chapin III et al., *Role of Land-Surface Changes in Arctic Summer Warming*, 310 SCI. 657, 657 (noting that the "continuation of current trends in . . . tree expansion [in arctic Alaska] could further amplify . . . atmospheric heating by two to seven times").

[70] Pete Smith & Daniel Martino, *Agriculture*, CLIMATE CHANGE 2007: MITIGATION OF CLIMATE CHANGE. CONTRIBUTION OF WORKING GROUP III TO THE FOURTH ASSESSMENT REPORT OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE 506–08 (Bert Metz et al. eds.).

[71] *Id.* at 510.

[72] *See id.* at 512.

potential.[73]

4. Efficiency and Conservation

Efficiency covers a wide array of means to reduce emissions, including improved technology to produce more energy from less fuel,[74] and efforts to conserve the amount of energy consumed. Often called the "low-hanging fruit" of climate change mitigation, efficiency measures can contribute substantial reductions in greenhouse gas emissions.[75] Indeed, individuals can reduce their greenhouse gas emissions by approximately 60 percent through behavioral changes—such as installing more energy efficient water heaters and altering driving habits.[76] The Carbon Mitigation Initiative at Princeton University estimates that efficiency measures—including increasing the fuel efficiency of cars and producing coal-based energy at double the current efficiency—could reduce future greenhouse gas emissions by at least 4 billion tons per year by 2060.[77] Efficiency thus represents a unique combination of individual choices and technological improvements that can effectively contribute to climate change mitigation.[78]

Each group of mitigation measures, from efficiency to renewable energy, has the potential to contribute substantially to mitigation. Various policy tools are also available to policymakers and planners to encourage the expanded use of these measures.

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[73] For more on potential reductions in greenhouse gas concentrations from the agricultural sector, *see generally* Pete Smith et al., *Agriculture, Forestry and Other Land Use*, CLIMATE CHANGE 2014: MITIGATION OF CLIMATE CHANGE. CONTRIBUTION OF WORKING GROUP III TO THE FIFTH ASSESSMENT REPORT OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE 22–39 (Ottmar Edenhofer et al. eds.).

[74] *See*, Barker et. al., *supra*, note 42, at 10.

[75] *See* Richard J. Lazarus, *Super Wicked Problems and Climate Change: Restraining the Present to Liberate the Future*, 94 CORNELL L. REV. 1153, 1192 (2009); *see also* Barker et al., *supra* note 42, at 10 (noting that efficiency plays an important role in greenhouse gas emissions reductions in the energy, transportation, building, industrial, and agricultural sectors).

[76] *See* Michael P. Vandenbergh & Anne C. Steinemann, *The Carbon-Neutral Individual*, 82 N.Y.U. L. REV. 1673, 1699-1703 (2007).

[77] *See Stabilization Wedges Introduction*, *supra* note 44.

[78] For a more thorough discussion of individual efficiency choices, *see* Vandenbergh & Steinemann, *supra* note 76, at 1699-1703. For more on how efficiency can contribute to an overall mitigation strategy, *see generally*, Detlef P. van Vuuren et al., *Stabilizing Greenhouse Gas Concentrations at Low Levels: An Assessment of Reduction Strategies and Costs*, 81 CLIMATIC CHANGE 119 (2007) (discussing, *inter alia*, how "investments into energy efficiency could therefore form a very cost-effective [mitigation] measure" if certain barriers are removed).

C. Mitigation Policy Tools

Just as there are broad categories of substantive mitigation measures, there are general policy tools for promoting mitigation.[79] These policies include command-and-control regulation, cap-and-trade, carbon taxes, and government subsidies.[80] Additionally, demand-side management, including education initiatives, can promote mitigation through greater efficiency and conservation.[81] Each of these tools has proponents and opponents, and benefits and limitations, a full discussion of which is beyond the scope of this Article. Accordingly, this section only briefly discusses the policy tools.

1. Command-and-Control Regulation

Command-and-control regulation is a traditional form of environmental protection, and many of the oldest U.S. pollution statutes utilize it.[82] Generally, command-and-control regulations require a polluter to reduce the output of pollution to prescribed levels either by requiring the polluter to adopt specified technologies or by setting a minimum level of performance that polluters must meet.[83] Currently in the United States, command-and-control regulation under the Clean Air Act (CAA) is the default policy for climate change mitigation.[84] In 2007, the Supreme Court held in *Massachusetts v. EPA* that carbon dioxide and other greenhouse gases were pollutants under the CAA,[85] and that the EPA must regulate greenhouse gases if it found that those gases contribute to climate change or could not provide "some reasonable explanation as to why it cannot or will not exercise its discretion to determine whether they do."[86] The EPA subsequently issued an Endangerment and Cause or Contribute Finding, a Tailpipe Rule requiring increased mileage standards for cars and light trucks, and Timing and Tailoring Rules that specified which stationary sources would

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[79] *See* SHI-LING HSU, THE CASE FOR THE CARBON TAX: GETTING PAST OUR HANG-UPS TO EFFECTIVE CLIMATE POLICY 15 (2011).

[80] *Id.*

[81] *See, e.g.*, Mark Levine & Diana Ürge-Vorsatz, *Residential and Commercial Buildings*, *in* CLIMATE CHANGE 2007: MITIGATION. CONTRIBUTION OF WORKING GROUP III TO THE FOURTH ASSESSMENT REPORT OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE 425–26, 432-34 (Bert Metz et al. eds.) (discussing demand-side management and education as policy tools with potentially high impacts on emissions reductions).

[82] HSU, *supra* note 79, at 17.

[83] *Id.* at 17–18.

[84] Richard B. Herzog & Nicholas W. Fels, *Offsets Under S111 of the Clean Air Act: The Inconvenient Need for Additionality and the Role of Super-Categories*, 43 ENVTL. L. REP. NEWS & ANALYSIS 10257–58 (2013) (noting that section 111 of the Clean Air Act "emerged" as the primary mode of regulating greenhouse gases from stationary sources after the Supreme Court's decision in *Massachusetts v. EPA*).

[85] 549 U.S. 497, 532 (2007).

[86] *Id.* at 533.

be subject to greenhouse gas regulations under the CAA.[87] In 2012, the D.C. Circuit held that the Endangerment Finding was not arbitrary and capricious, and that various petitioners did not have standing to challenge the Timing and Tailoring Rules.[88] Ostensibly following the *Chevron* doctrine, however, the Supreme Court in *Utility Air Regulatory Group v. EPA* found that greenhouse gases alone do not trigger the PSD and Title V programs of the CAA, nor was such an interpretation by the EPA permissible.[89] The Court also struck down the Tailoring Rule, holding that the EPA impermissibly rewrote "precise numerical thresholds at which the Act requires PSD and Title V permitting."[90] The victory for industry was small, however, as the Court upheld the EPA's authority to regulate greenhouse gases "emitted by sources otherwise subject to PSD review."[91] Even without the PSD and Title V triggers, the EPA might still reach as much as 83% of greenhouse gas emissions from stationary sources, only 3% less than with the triggers.[92]

In 2014, the EPA proposed a Carbon Pollution Standard for new power plants that would limit carbon dioxide emissions from coal fired power plants to 1,100 tons per megawatt hour, and natural gas plants to 1,000 tons of per megawatt hour.[93] EPA also proposed emission guidelines for existing stationary sources to be implemented under state implementation plans through a "best system of emissions reduction" approach.[94] It is not clear, however, that these new rules will see implementation, particularly if Congressional Republicans are successful in their attempts to block them.[95]

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[87] *See* David Markell & J.B. Ruhl, *An Empirical Assessment of Climate Change in the Courts: A New Jurisprudence or Business As Usual?*, 64 FLA. L. REV. 15, 49–53 (2012). The Timing and Tailoring rules limited PSD applicability to new or modified sources emitting over 75,000 tons-per-year of carbon dioxide equivalent. Prevention of Significant Deterioration and Title V Greenhouse Gas Tailoring Rule, 75 Fed. Reg. 31,514 (June 3, 2010) (to be codified at 40 C.F.R. pts. 51, 52, 70, 71).

[88] Coal. for Responsible Regulation, Inc. v. E.P.A., 684 F.3d 102, 122-23, 146-48 (D.C. Cir. 2012), *aff'd in part and rev'd in part by UARG*,134 S.Ct. 2427 *infra* note 89.

[89] Utility Air Regulatory Group v. E.P.A., 134 S.Ct. 2427, 2442 (2014), 573 U.S. __ (2014).

[90] *Id.* at 2445.

[91] *Id.* at 2448.

[92] *Id.* at 2438-9. With the PSD and Title V triggers, EPA might have reached 86% of emissions. *Id.*

[93] Standards of Performance for Greenhouse Gas Emissions from New Stationary Sources: Electric Utility Generating Units, 79 Fed. Reg. 1429 (Jan. 8, 2014) (to be codified at 40 C.F.R. pts. 60, 70, 71, and 98). The EPA previously proposed a rule for new and majorly modified stationary sources in 2012, *see* Standards of Performance for Greenhouse Gas Emissions for New Stationary Sources: Electric Utility Generating Units, 77 Fed. Reg. 22,392 (April 13, 2012) (to be codified at 40 C.F.R. pt. 60), but scrapped that rule after the commenting period.

[94] Carbon Pollution Emission Guidelines for Existing Stationary Sources: Electric Utility Generating Units, 79 Fed. Reg. 34,829 (June 18, 2014) (to be codified at 40 C.F.R. pt. 60). The EPA claims that by 2030, these guidelines would achieve carbon dioxide emissions reductions of 30% compared to 2005 emissions levels. *Id.*

[95] *See, e.g.*, Darren Goode, *Mitch McConnell Launches Pre-Emptive Strike on EPA Climate*

Command-and-control regulations are thus familiar in the United States, and are already used to mitigate climate change. It is clear, however, that current command-and-control regulations are insufficient to curb the worst consequences of climate change, and new regulations and new mitigation policies will likely be necessary.

2. Cap-and-Trade

Cap-and-trade is an increasingly popular mitigation policy that "involve[s] the issuance of *allowances* to polluters that permit them to emit a quantity of pollution."[96] There are various ways of implementing cap-and-trade programs, but all generally involve a cap on total emissions allowed, with some caps "harder" than others.[97] Depending on the system, polluters might be issued allowances or purchase them in an auction; subsequently, polluters who emit less can sell (or trade) their allowances to other polluters who cannot meet their allowed emissions limits.[98] Some versions of cap-and-trade include credits that can substitute for allowances, called "offsets," that "do not necessarily reduce existing emissions, but reduce or 'offset' emissions that *would otherwise* occur."[99]

Greenhouse gas cap-and-trade programs have been implemented on an international level,[100] and domestically at both the state and regional level. California, for instance, has its own cap-and-trade program,[101] and regional programs exist in the Northeastern and Midwestern United States.[102] At the federal level, a cap-and-trade bill passed the House of Representatives in 2009, but was not considered by the Senate.[103] While some politicians have demonized

Rule, POLITICO, http://www.politico.com/story/2014/01/mitch-mcconnell-epa-climate-rule-102272.html (last visited Oct. 25, 2014).

[96] HSU, *supra* note 79, at 20.

[97] *Id.* at 21–22.

[98] *Id.* at 20.

[99] *Id.* at 21. Offsets are controversial because, *inter alia*, "it is impossible to know whether the proposed project would actually reduce emissions." *Id.* at 88.

[100] *Id.* at 21 (noting that the European Union has adopted a cap-and-trade program).

[101] *Cap-and-Trade Program*, CAL. ENVTL. PROTECTION AGENCY, http://www.arb.ca.gov/cc/capandtrade/capandtrade.htm (last visited Oct. 25, 2014).

[102] John C. Dernbach & Seema Kakade, *Climate Change Law: An Introduction*, 1 ENERGY L. J. 19 (2008) (describing the Regional Greenhouse Gas Initiative in the Northeast and the Western Climate Initiative in the Southwest). Many states have subsequently dropped out of the Western Climate Initiative, leaving only California British Columbia, and Québec. *See Board of Directors*, W. CLIMATE INITIATIVE, http://www.wci-inc.org/board-directors.php (last visited Oct. 25, 2014). In addition to the two aforementioned regional cap and trade programs, the Midwestern Regional Greenhouse Gas Reduction Accord attempted a cap and trade program, but the states "did not continue pursuing their greenhouse gas goals through the Accord." *Multi-State Climate Initiatives*, CTR. FOR CLIMATE AND ENERGY SOLUTIONS, http://www.c2es.org/us-states-regions/regional-climate-initiatives#MGGRA (last visited Oct. 25, 2014).

[103] Roberta F. Mann, *Federal, State, and Local Tax Policies for Climate Change: Coordination*

cap and trade programs as "cap and tax,"[104] such programs are not the same as actual taxes on carbon.

3. Carbon Tax

A carbon tax is, simply, a tax on carbon in the form of greenhouse gases, or a tax on carbon that will become greenhouse gases.[105] It can be levied upstream—near the extraction point—or downstream—near the point of consumption—or somewhere in between.[106] For instance, a consumer can pay a carbon tax at the gas station when filling up (downstream), or an oil producer can pay a carbon tax on wholesale barrels of oil (upstream).[107] It can be levied on products that emit greenhouse gases, like cars or gasoline, or directly on emissions.[108] Generally, the tax is set at a lower level and then increases over time to account for inflation and progressively discourage emissions.[109] A carbon tax, therefore, discourages the use of energy sources that produce significant emissions by making the energy more expensive, a converse strategy of governmental subsidies.

4. Government Subsidies

Unlike carbon taxes or cap-and-trade programs, which "seek to raise the price of all things carbon," government subsidies attempt to reduce the cost of no- or low-carbon products or services.[110] Subsidies may be awarded directly to, for instance, renewable energy producers—this is known as a price-oriented subsidy—or they may be channeled into research and development.[111] While precisely delineating subsidies is challenging because they take many shapes,[112]

or Cross-Purpose?, 15 LEWIS & CLARK L. REV. 369, 374 (2011).

[104] *See, e.g.*, Sarah Palin, Op-ed, *The "Cap and Tax" Dead End*, WASH. POST. (July 14, 2009), http://articles.washingtonpost.com/2009-07-14/opinions/36927469_1_energy-sector-energy-policy-economic-growth-and-energy.

[105] For a more thorough explanation of a carbon tax, *see* Sujata Gupta & Dennis A. Tirpak, *Policies, Instruments, and Co-operative Arrangements*, *in* CLIMATE CHANGE 2007: MITIGATION OF CLIMATE CHANGE. CONTRIBUTION OF WORKING GROUP III TO THE FOURTH ASSESSMENT REPORT OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE 755–56 (Bert Metz et al. eds.).

[106] HSU, *supra* note 79, at 15–16.

[107] Gupta & Tirpak, *supra* note 105, at 756.

[108] *Id.*

[109] *See id.*

[110] HSU, *supra* note 79, at 23.

[111] *Id.*

[112] *Id.* at 24. For instance, Jack Gerard, the president of the American Petroleum Institute (API), claims that the "oil and gas industry gets no subsidies, zero, nothing." John M. Broder, *Hands Off, Oil Industry Warns Government*, N.Y. TIMES BLOG (Jan. 8, 2013), http://green.blogs.nytimes.com/2013/01/08/hands-off-oil-industry-warns-government/. Despite Gerard's claims, however, fossil fuel companies receive billions of dollars in tax reductions, a form of preferential tax treatment that API previously labeled subsidies in relation to renewable energy. *See* Rebecca Leber, *Big Oil Lobby*

by lowering the cost of no- and low-carbon sources of energy, subsidies can make those energy sources more price competitive with traditional fossil fuels.

5. Demand-side Management

Demand-side management (DSM) includes a host of tools to encourage energy consumers to use less energy, or to use energy during off-peak times.[113] DSM includes programs to encourage the use of appliances that utilize less energy—such as Energy Star certified appliances—and technologies that allow consumers or utilities to monitor and control energy use.[114] It also includes efforts to provide consumers with information about energy use and ways to change consumption habits to produce less greenhouse gas emissions.[115] Other measures, like demand bidding programs, actually allow for consumers or consumer aggregators to bid into electricity markets with promises not to use energy.[116] In other words, the consumer is paid to curtail power use during busy times. DSM programs encourage or help consumers to use less energy, or shift their energy use to off-peak periods when the dirtiest "peaker" plants are not running.[117]

A suite of mitigation tools is available to reduce greenhouse gas emissions and hopefully curb the worst consequences of climate change. As some climate change consequences are unavoidable, however, substantive adaptation tools will also be necessary.

D. Substantive Adaptation

Unlike mitigation, adaptation measures cannot be so easily categorized in broad groups, and are far more complicated response mechanisms.[118] The spatial and temporal variations in the effects of climate change generally necessitate

Claims the Industry "Gets No Subsidies, Zero, Nothing," CLIMATE PROGRESS (Jan. 9, 2013), http://thinkprogress.org/climate/2013/01/09/1423351/oil-zero-subsidies/. Indeed, the International Monetary Fund estimated that 10.62% of government revenue in the United States went to post-tax subsidies, either explicitly or implicitly, for petroleum, coal, and natural gas. *See* INT'L MONETARY FUND, ENERGY SUBSIDY REFORM: LESSONS AND IMPLICATIONS 62 (2013), *available at* http://www.imf.org/external/np/pp/eng/2013/012813.pdf.

[113] *See* David S. Loughran & Jonathan Kulick, *Demand-side Management and Energy Efficiency in the United States*, 25 THE ENERGY J. 19, 19 (2004).

[114] *Demand-side Management*, PACIFICORP, http://www.pacificorp.com/env/dsm.html (last visited Oct. 25, 2014).

[115] *Id.*

[116] Peter Palensky, *Demand Side Management: Demand Response, Intelligent Energy Systems, and Smart Loads*, 7 IEEE TRANSACTIONS ON INDUS. INFORMATICS 381, 382 (2011).

[117] *See* BRANDON DAVITO ET AL., MCKINSEY & CO., THE SMART GRID AND THE PROMISE OF DEMAND-SIDE MANAGEMENT 38 (2010) (noting that DSM programs help energy consumers shift "their own demand for electricity during peak periods, reducing their energy consumption overall"); *see also Demand-side Management*, *supra* note 114.

[118] Craig, *supra* note 8, at 15.

adaptive measures tailored to specific geographic features and populations.[119] Nevertheless, some general adaptation distinctions are identifiable. Adaptation options are distinguishable by spatial scale, and can take place at the local, regional, or national level.[120] Similarly, those options are distinguishable by the actors that carry out the adaptation. For instance, specific measures may be carried out by entities at various levels of government, private sector actors, or non-profit groups.[121] Additionally, adaptation measures can be divided sectorally, with measures implemented by, *inter alia*, the agricultural, public health, tourism, and water management sectors.[122] Further, adaptation measures can be divided into temporal categories dependent on when the adaptation is to occur.[123] None of these categories is preclusive, and there may be overlap within or between the categories.

In addition to general categories of adaptation, there are some specific adaptation practices that are likely to be necessary on a large scale, a few of which are discussed here. One of the most visible, and potentially catastrophic consequences of climate change is damage that results from rising sea levels.[124] Accordingly, "investment in coastal protection infrastructure to reduce vulnerability to storm surges and anticipated sea-level rise" is likely to be a widespread form of substantive adaptation.[125] Such measures include the use of dikes, levees, seawalls, bulkheads, gates, and restored wetlands.[126]

Climate change is expected to increase the number of refugees worldwide seeking asylum, either intra- or internationally.[127] Adapting to the influx of new refugees will likely be a challenge for many nations around the world, and will require local, national, and global responses.[128]

Climate change poses particular difficulties for the agricultural sector due to

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[119] *See* Victoria Flatt, *Adapting Laws for a Changing World: A Systemic Approach to Climate Change Adaptation*, 64 FLA. L. REV. 269, 271–72 (2012).

[120] W. Neil Adger et al., *Assessment of Adaptation Practices, Options, Constraints and Capacity*, CLIMATE CHANGE 2007: IMPACTS, ADAPTATION AND VULNERABILITY. CONTRIBUTION OF WORKING GROUP II TO THE FOURTH ASSESSMENT REPORT OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE 720 (Martin L. Parry et al. eds., 2007).

[121] *Id.*

[122] *Id.*

[123] *Id.* ("[A]daptation to climate risks can be viewed at three levels, including responses to: current variability (which also reflect learning from past adaptations to historical climates); observed medium and long-term trends in climate; and anticipatory planning in response to model-based scenarios of long-term climate change.").

[124] *See* ALLISON ET AL., *supra* note 4, at 37–38.

[125] Adger et al., *supra* note 120, at 720.

[126] *See, e.g.*, DEP'T OF CITY PLANNING CITY OF N.Y., *Increase Climate Resilience*, VISION 2020: NEW YORK CITY COMPREHENSIVE WATERFRONT PLAN 110 (2011), *available at* http://www.nyc.gov/html/dcp/pdf/cwp/vision2020_nyc_cwp.pdf.

[127] *See* Bonnie Docherty & Tyler Giannini, *Confronting a Rising Tide: A Proposal for a Convention on Climate Change Refugees*, 33 HARV. ENVTL. L. REV. 349, 352–57 (2009).

[128] McAllister, *supra* note 23, at 2121.

changes in the hydrological cycle, temperature, extreme weather events, destructive pests, and growing seasons, among other things.[129] In response to the challenges faced by the agricultural sector, a variety of adaptation practices are available.[130] These practices include a number of methods to combat water shortages, such as supplementary irrigation, a "wider use of technologies to 'harvest' water," and measures to conserve soil moisture.[131] Additionally, agricultural adaptation measures include altering or diversifying crop selection for increased resiliency, and changing livestock practices.[132]

Cities will also face unique adaptation challenges. In many urban centers that have long had cool climates, many residences do not have air conditioning.[133] As the climate warms, heat-related deaths, particularly from heatwaves, become an increasing problem;[134] accordingly, widespread dispersal and installation of air conditioning may be critical.[135] Water quality concerns are also important in urban centers, and adapted wastewater treatment centers will likely be necessary in many coastal urban areas.[136]

Ensuring adequate water supply and quality will be a critical element of adaptation, particularly in areas where climate change is exacerbating already

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[129] *See* William Easterling & Pramod Aggarwal, *Food, Fibre and Forest Products*, CLIMATE CHANGE 2007: IMPACTS, ADAPTATION AND VULNERABILITY. CONTRIBUTION OF WORKING GROUP II TO THE FOURTH ASSESSMENT REPORT OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE 282–85 (Martin L. Parry et al. eds., 2007).

[130] Adger et al., *supra* note 120, at 721.

[131] Easterling & Aggarwal, *supra* note 129, at 294–96.

[132] *Id.* at 294–95. Some livestock adaptation practices include:

matching stocking rates with pasture production, rotating pastures, modifying grazing times, altering forage and animal species/breeds, altering the integration of mixed livestock/crop systems, including the use of adapted forage crops, re-assessing fertiliser applications, ensuring adequate water supplies and using supplementary feeds and concentrates.

[133] *See* U.S. ENERGY INFO. ADMIN., AIR CONDITIONING IN HOMES IN NORTHEAST REGION, DIVISIONS, AND STATES, 2009 & AIR CONDITIONING IN HOMES IN MIDWEST REGION, DIVISIONS, AND STATES, 2009, *available at* http://www.eia.gov/consumption/residential/data/2009/#undefined (click on "Air Conditioning" and select region) (finding over 5 million homes in the Northeast and Midwest have no air conditioning equipment).

[134] *See* Ulisses Confalonieri & Bettina Menne, *Human Health*, CLIMATE CHANGE 2007: IMPACTS, ADAPTATION AND VULNERABILITY. CONTRIBUTION OF WORKING GROUP II TO THE FOURTH ASSESSMENT REPORT OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE 396 (Martin L. Parry et al. eds., 2007).

[135] *Id.* at 418 (noting that "air conditioning of private and public spaces is a primary measure used in the USA to reduce heat-related morbidity and mortality"). For an example of the havoc heat waves can wreak on unprepared urban centers, *see* Eric Klinenberg, *When Chicago Baked: Unheeded Lessons from Another Great Urban Catastrophe*, SLATE (Sep. 2, 2005, 5:34 PM), http://www.slate.com/articles/news_and_politics/history_lesson/2005/09/
when_chicago_baked.html (discussing the 1995 Chicago heat wave that killed over 700 people in a week); Marc Poumadére et al., *The 2003 Heat Wave in France: Dangerous Climate Change Here and Now*, 25 RISK ANALYSIS 1483 (2005) (discussing the Parisian heat wave of 2003 that killed nearly 15,000 people).

[136] Adger et al., *supra* note 120, at 724 (discussing the decision to keep a sewage treatment plant at a higher elevation in Boston to guard against rising sea levels).

fragile conditions.[137] Many specific water management strategies have been used for years and, though not specifically tailored to climate change, may prove beneficial in adapting.[138] For instance, expanded use of rainwater storage and water markets addresses supply-side and demand-side adaptation options, respectively.[139] Many U.S. urban centers are already incorporating water-market arrangements into long-term planning.[140]

As noted above, the previous discussion only highlights a few of the many adaptation measures that will likely be necessary in the coming century.[141] The following discussion highlights some of the policy tools that may be used to implement or encourage the specific adaptation measures.

E. Adaptation Policy Tools

Just as substantive adaptation measures are more diverse and complicated than mitigation measures, policy tools to implement adaptation are more varied and less established than the mitigation policies discussed above.[142] Specific policy proposals can, like specific measures, be divided by sector affected. For instance, policies for water resource adaptation include conserving water, adopting contingency planning for droughts, and using transfers of water between water basins.[143] Adaptation policy responses to sea level rise include limiting government subsidies for coastal development, incorporating sea level rise into urban planning, and preserving coastal wetlands.[144] Agricultural adaptation policy options include developing new seed varieties and altering crop subsidies that support individual crop types.[145]

More general adaptation policies are also available. Maybe the most important of these is "mainstreaming," a process whereby adaptation measures

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[137] *See* Zbigniew W. Kundzewicz & Luis José Mata, *Freshwater Resources and Their Management*, CLIMATE CHANGE 2007: IMPACTS, ADAPTATION AND VULNERABILITY. CONTRIBUTION OF WORKING GROUP II TO THE FOURTH ASSESSMENT REPORT OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE 175 (Martin L. Parry et al. eds., 2007) (finding high confidence that "[s]emi-arid and arid areas are particularly exposed to the impacts of climate change on freshwater").

[138] *See id.* at 196.

[139] *See id.* at 197.

[140] *E.g.*, *id.* at 198.

[141] For a far more thorough discussion of adaptation, *see* CLIMATE CHANGE 2007: IMPACTS, ADAPTATION AND VULNERABILITY. CONTRIBUTION OF WORKING GROUP II TO THE FOURTH ASSESSMENT REPORT OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE (Martin L. Parry et al. eds., 2007).

[142] One of the more notable adaptation policy tools is technology transfer, *see* Adger et al., *supra* note 120, at 731, but as it applies primarily to the transfer of technology from developed nations like the United States to developing nations, it will not be addressed in detail here.

[143] Joel B. Smith & Stephanie S. Lenhart, *Climate Change Adaptation Policy Options*, 6 CLIMATE RES. 193, 196 (1996).

[144] *Id.* at 197.

[145] *Id.* at 199.

are integrated "into some aspect of related government policy such as water management, disaster preparedness and emergency planning or land-use planning."[146] Mainstreaming is not, therefore, a specific policy proposal, like a carbon tax, but rather a policy *for* policy proposals. For instance, community planning might incorporate adaptation measures at all levels, instead of merely implementing adaptation measures as needed.[147] Similar examples of mainstreaming might "include integration of climate information into environmental data sets, vulnerability or hazard assessments."[148] Constraints on mainstreaming include the "(a) relevance of climate information for development-related decisions; (b) uncertainty of climate information; (c) compartmentalisation with governments; (d) segmentation and other barriers within development-cooperation agencies; and (e) trade-offs between climate and development objectives."[149]

Mitigation and adaptation, adopted through various policies and measures, provide an opportunity to combat the negative consequences of climate change. Traditionally, the two climate change responses have been analyzed in isolation. Moving forward, however, an integrated approach to analyzing mitigation and adaptation options is warranted.

III. EXPLORING THE INTERSECTION OF MITIGATION AND ADAPTATION

Scholars have recently begun exploring the intersection of mitigation and adaptation.[150] The hope is to identify synergies, unintended consequences, and trade-offs, between the two. Synergies provide an opportunity to craft measures, laws, and policies that efficiently address both mitigation and adaptation in tandem. Identifying unintended consequences and trade-offs allows for informed decisionmaking that avoids or minimizes the pain associated with our response to climate change.[151] There has been debate in the literature about the value of integrating mitigation and adaptation,[152] and the limitations of an integrated approach are addressed *infra*. Indeed, it is not clear that an integrated approach

[146] Adger et al., *supra* note 120, at 732.

[147] *See id. But see id.* ("There are few examples of successful mainstreaming of climate change risk into development planning.").

[148] *Id.*

[149] *Id.*

[150] *See, e.g.*, Klein et al., *supra* note 8, at 748.

[151] As Robin Craig notes, humankind's response to climate change will be painful, and we must accept that fact if we are to respond successfully. *See* Craig, *supra* note 8, at 69–70. We do not have to accept, however, needlessly painful climate change responses that result from under-informed decisionmaking.

[152] Swart & Raes, *supra* note 8, at 296 (noting, for example, that "capturing adaptation and mitigation in one model [at the regional and national level] makes little sense" due to spatial and temporal contrasts).

to the implementation of mitigation and adaptation is sensible in all cases.[153] Nevertheless, there are substantial arguments for examining the two climate responses collectively. Accordingly, this Part first examines why an integrated approach to mitigation and adaptation is warranted. It then discusses the nature of synergies and trade-offs inherent in an integrated approach to climate change.

A. Where Mitigation and Adaptation Intersect

At the core, the argument for viewing mitigation and adaptation collectively is simple: neither mitigation nor adaptation can singularly reduce all of the burdens of climate change, and one inherently affects the other.[154] Mitigation of climate change can reduce the amount of future warming, but cannot prevent all future warming because, as noted above, an unknown degree of future climate change is guaranteed by warming "in the pipeline."[155] Because future warming to some extent is guaranteed, regardless of the magnitude and intensity of mitigation, adaptation will be necessary to offset the undesirable consequences.[156] Focusing on adaptation alone, however, is similarly an unacceptable option. Without any mitigation, the consequences of climate change are likely to be so severe that adaptation is simply impossible for many natural and anthropogenic systems.[157] In short, adaptation, like mitigation, cannot succeed in a vacuum.

The primary reason adaptation cannot succeed in a vacuum is uncertainty. Indeed, policymakers and planners confront myriad uncertainties when they devise adaptation measures, policies, and laws.[158] The science of climate change is itself littered with uncertainty: For instance, what is the climate sensitivity to a doubling of carbon dioxide?[159] How will temperature and precipitation patterns

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[153] *See* McAllister, *supra* note 23, at 2123.

[154] *See* Ruhl, *supra* note 13, at 370 ("[M]itigation needs adaptation, and vice versa, even if they fundamentally are different and sometimes competing policy thrusts".).

[155] *See* discussion, *supra*, in and accompanying notes 9–11.

[156] *See, e.g.*, Klein et al., *supra* note 8, at 747 ("Even the most stringent mitigation efforts cannot avoid further impacts of climate change in the next few decades . . . which makes adaptation unavoidable.").

[157] Swart & Raes, *supra* note 8, at 294 ("[N]atural and human systems [will] at some point be unable to adapt.").

[158] Alan Ingham et al., *Climate Change, Mitigation and Adaptation with Uncertainty and Learning*, 35 Energy Pol'y 5354 (2007); *see also* Biesbroek et al., *supra* note 16, at 232; Swart & Raes, *supra* note 8, at 289 ("[T]he perceived larger uncertainties involved in adaptation (where, by whom, to what?) played a role in lower levels of attention to adaptation."); Camacho, *supra* note 14, at 1 (arguing that "unprecedented uncertainty" is the "paramount impediment raised by climate change"). For a discussion of how uncertainties affect model projections of climate change, *see* Matthew Collins et al., *in Long-Term Climate Change: Projections, Commitments, and Irreversibility* CLIMATE CHANGE 2013: THE PHYSICAL SCIENCE BASIS. CONTRIBUTION OF WORKING GROUP I TO THE FIFTH ASSESSMENT REPORT OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE 1135–44 (Thomas F. Stocker et al. eds., 2007).

[159] The IPCC no longer offers a "best estimate" of climate sensitivity because of debate in the literature. *Summary for Policymakers*, *in* CLIMATE CHANGE 2013: THE PHYSICAL SCIENCE BASIS.

change in an individual region? Will the Greenland or West Antarctic ice-sheets destabilize and begin an unstoppable melt? If so, when, and how much sea-level rise will result? How will ecological systems respond to a specific temperature increase? Which invasive species are likely to move poleward? Which regions are most susceptible to spreading infectious diseases? How will climate change affect the quantity and intensity of hurricanes?[160]

Beyond the uncertainties in the rate, magnitude, impacts, and spatial variability of climate change, there are uncertainties in how to best respond to the consequences that do manifest. For instance, what will be the best way for Miami to adapt to sea level rise?[161] How will Kansas's farms cope with longer, hotter, and drier growing seasons? Will northern municipalities choose to subsidize the installation of air conditioning in areas that previously did not require it, or will they find a different solution? How will southern states respond to the infiltration of sub-tropical diseases?

Underlying and compounding all of these uncertainties, however, is the variable over which humans have the most control—mitigation.[162] The rate and magnitude of and appropriate responses to climate change will depend on the degree of mitigation in which society engages. A simple example can demonstrate the dynamic between adaptation and mitigation. Hurricanes Irene and Sandy, in 2011 and 2012, respectively, demonstrated that New York City is susceptible to destructive storm surges as sea levels rise.[163] Consequently, the city government is currently reviewing adaptation strategies for the city that include building higher seawalls to prevent future storm surges from inundating

CONTRIBUTION OF WORKING GROUP I TO THE FIFTH ASSESSMENT REPORT OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE 14, n.16 (Thomas F. Stocker et al. eds., 2007), *available at* http://ipcc.ch/report/ar5/wg1/docs/WGIAR5_SPM_brochure_en.pdf. The previous best estimate was three degrees Celsius. *See* LENNY BERNSTEIN ET AL., INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, CLIMATE CHANGE 2007: SYNTHESIS REPORT 38 (Abdelkader Allali et al. eds., 2007). This figure is consistent with many studies of climate sensitivity, though some newer studies indicate that climate sensitivity may be lower. *See* Dana Nucitelli, *Making Sense of Sensitivity . . . and Keeping it in Perspective*, SKEPTICAL SCI., http://www.skepticalscience.com/hausfather-economist-sense-of-sensitivity.html (last visited Oct. 25, 2014). It is important to note that equilibrium sensitivity merely reflects the planet's response temperature to a doubling of carbon dioxide over pre-industrial levels. Under several scenarios, emissions will more than double and the warming will exceed the equilibrium sensitivity. *See, e.g.*, Collins et al., *supra* note 158, at 1112–13. Moreover, the model projections used by the IPCC do not factor in possible GHG releases from the Arctic permafrost or methane hydrates, which could increase warming even further. *Id.* at 1112.

[160] For a thorough discussion of possible impacts of climate change in the United States, and how uncertainty affects those impacts, see generally U.S. GLOBAL CHANGE RESEARCH PROGRAM, GLOBAL CLIMATE CHANGE IMPACTS IN THE UNITED STATES (Thomas R. Karl et al. eds., 2009).

[161] *See* Ruhl, *supra* note 13, at 388 & 402-03.

[162] *See* McAllister, *supra* note 23, at 2122 (noting the "most intractable uncertainty . . . may regard the sufficiency of mitigation and adaptation efforts in light of the risk of nonlinear changes in climate").

[163] *See* Doyle Rice, *Weather Service Changes Warning System After Sandy*, USA TODAY (April 4, 2013), http://www.usatoday.com/story/weather/2013/04/04/hurricane-sandy-warnings/2052773/.

Manhattan.[164] Planners will be challenged, however, to choose an appropriate height for the new seawall. If the city builds an additional five feet of seawall, it may be more than enough to compensate for the storm surges resulting from a sea level rise accompanying warming of two degrees centigrade over pre-industrial levels. But if society does not sufficiently mitigate, and warming exceeds four degrees over pre-industrial levels, five feet may prove exceedingly inadequate. In such a situation, New York may find itself in a constant game of catch-up.[165] Conversely, the city might build a wall that is twenty feet higher, but if the world mitigates enough to constrain warming, then the city will have expended tremendous amounts of money—and simultaneously damaged property values—to prepare for an outcome that will not happen.[166]

Without a concomitant focus on mitigation, adaptation measures are shooting at a moving target,[167] and further examples of this problem are numerous. Using our Kansas farms example from above, increased irrigation may be an acceptable solution at one level of climate change, while at another, it may simply be better to concede the area to an increasingly desertified environment.[168] Midwestern farms may require soil conservation measures initially, and then advanced irrigation measures later. For Miami, seawalls and artificial barrier islands may be a solution for two degrees of temperature

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[164] *See* Becky Bratu, *Ideas on Protecting New York from Future Storms Float to Surface*, NBCNEWS.COM (Nov. 10, 2012) (noting New York City's renewed focus on coastal protection in the wake of Hurricane Sandy). The City previously commissioned a report discussing waterfront planning, including a discussion of sea level rise. DEP'T OF CITY PLANNING CITY OF N.Y., *Increase Climate Resilience, in* VISION 2020: NEW YORK CITY COMPREHENSIVE WATERFRONT PLAN 105–12 (2011), *available at* http://www.nyc.gov/html/dcp/pdf/cwp/vision2020_nyc_cwp.pdf (discussing adaptation measures including, *inter alia*, seawalls, bulkheads, revetments, dikes, levees, breakwaters).

[165] For an example of this type of uncertainty in planning for sea level rise, *see* Adger et al., *supra* note 120, at 725 (finding that "floodproofing" measures are superior to coastal protection measures for a sixty centimeter sea-level rise in Boston, but that coastal protection measures such as seawalls and bulkheads were superior for a one meter rise).

[166] *See, e.g.*, Swart & Raes, *supra* note 8, at 292 ("[P]roactive adaptive actions may not have any benefit at all at any time scale, if climate changes do not materialize, or if the changes are very different from what is expected.").

[167] *See* Ruhl, *supra* note 13, at 375 & 380 n.44. While this Article focuses on the need for domestic mitigation, mitigation in the United States alone clearly will not be sufficient to curb climate change, especially with the rapid increase in emissions from developing nations, particularly China and India. *See* David Ferris, *As Coal Use Drops in U.S., China and India Burn Even More*, FORBES (Nov. 20, 2012), http://www.forbes.com/sites/davidferris/2012/11/20/as-coal-use-drops-in-u-s-china-and-india-burn-even-more/. It is unlikely, however, that either China or India will commit to large-scale mitigation unless the United States does so as well. As such, it is crucial that the United States implement more mitigation. The impact of the recent United States-China voluntary climate agreement on future mitigation efforts remains to be seen. Press Release, The White House, Office of the Press Secretary, U.S.-China Joint Announcement on Climate Change (Nov. 11, 2014), http://www.whitehouse.gov/the-press-office/2014/11/11/us-china-joint-announcement-climate-change.

[168] *See generally* Joseph Romm, *The Next Dust Bowl*, 478 NATURE 450 (2011) (discussing the "desertification" of the American west and Midwest).

increase, moving the population further inland a solution to four degrees, and abandonment of the area at six degrees.[169]

Mitigation and adaptation are thus inexorably intertwined, and neither is sufficient to address the effects of climate change. Yet the proportional relationship of mitigation to adaptation is not equal or obvious. The basic formula is this: more mitigation leads to less adaptation, while less mitigation leads to more adaptation.[170] Yet the converse is not necessarily true; while adaptation may have positive effects on mitigation, in some cases adaptation may, cruelly, lead to a greater need for mitigation.[171] For instance, increased distributions of air conditioners in northern cities to prevent heat-related deaths will likely lead to increased electricity use and, depending on the energy source, increased greenhouse gas emissions.[172] Other adaptation options "such as coastal protection infrastructure" may also lead to greater energy use and emissions.[173] Furthermore, the effects of mitigation are, generally, temporally separated from the resulting benefits, so that the relationship between mitigation and adaptation may not follow the basic formula.[174] In the near term, then, more mitigation may have little effect on the amount of adaptation required.[175]

Because both responses to climate change are so closely connected and are often interdependent, it is sensible to view mitigation and adaptation through a singular lens to find interactions between the two.

B. Synergies and Tradeoffs

As demonstrated above, mitigation measures may affect adaptation, and vice versa.[176] Because of those interactions, synergies and tradeoffs between adaptation and mitigation measures may exist,[177] and scholars are increasingly calling for consideration of both in formulating integrated climate policies.[178]

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[169] *See* Ruhl, *supra* note 13, at 35-87.

[170] Swart & Raes, *supra* note 8, at 290; *see also* Biesbroek et al., *supra* note 16, at 232.

[171] *See* Klein et al., *supra* note 8, at 750 ("For example, afforestation that is part of a regional adaptation strategy also makes a positive contribution to mitigation. In contrast, adaptation actions that require increased energy use from carbon-emitting sources (e.g., indoor cooling) would affect mitigation efforts negatively."); Swart & Raes, *supra* note 8, at 298 ("[M]any adaptation options, such as coastal protection infrastructure, additional cooling requirements and expanded irrigation, all increase energy use, often with associated GHG emissions, and thus increase the need for mitigation.").

[172] Klein et al., *supra* note 8, at 750; Swart & Raes, *supra* note 8, at 298.

[173] Swart & Raes, *supra* note 8, at 298.

[174] Klein et al., *supra* note 21, at 581. B*ut see* Swart & Raes, *supra* note 8, at 292 ("[I]t can also be observed that many mitigative actions can also have short-term benefits, e.g. in the form of reduced air pollution, or in some 'no-regrets' cases, in the form of economic benefits.").

[175] *See* Biesbroek et al., *supra* note 16, at 232.

[176] Klein et al., *supra* note 8, at 747.

[177] *Id.*

[178] *See* Ayers & Huq, *supra* note 19, at 757; Indur M. Goklany, *Integrated Strategies to Reduce*

Synergies between the strategies "are created when measures that control atmospheric greenhouse gas concentrations also reduce adverse effects of climate change, or vice versa."[179] In short, a synergy is a "win-win" situation.[180] A commonly used example is planting trees in urban areas, which simultaneously "sequester carbon as they grow and . . . reduce urban heat stress in summer."[181]

Other examples of synergy between climate mitigation and adaptation can be found in various sectors. For instance, adaptation efforts to conserve soil moisture and avoid erosion might also lead to greater carbon sequestration in the soil.[182] Integrated urban planning in coastal cities can lead to decreased exposure to storm surges and reduced energy use.[183] Proper development of hydropower can reduce emissions from energy generation and, if properly done, "limit vulnerability to [the] precipitation variability" that may result from climate change.[184]

Professor Lesley A. McAllister discusses the potential for synergies in the electric power sector.[185] Primarily, Professor McAllister focuses on water conservation that results from increased use of certain forms of renewable energy.[186] For example, Energy Secretary Ernest Moniz noted that the massive Ivanpah solar thermal plant, which came online in the Mojave Desert in February 2014, uses "roughly the same amount of water as two holes at the nearby golf course."[187] Further, Professor McAllister notes how decentralization of electricity production can decrease the vulnerability of the electric sector to extreme weather and climate events.[188]

Similarly, Professor Katherine A. Trisolini has identified three underutilized mitigation-adaptation measures that create synergies.[189] Efficiency measures in commercial buildings, such as improved insulation, can reduce energy use and simultaneously "shield[] residents from dangerous impacts of supply disruption

Vulnerability and Advance Adaptation, Mitigation, and Sustainable Development, 12 MITIGATION AND ADAPTATION STRATEGIES FOR GLOBAL CHANGE 755, 756 (2007).

179 Klein et al., *supra* note 21, at 582. Klein et al. note that this is an adaptation measure that does not have immediate benefits because the reduction in urban heat stress only occurs after the trees have grown sufficiently large. *Id.*

180 Ayers & Huq, *supra* note 19, at 757.

181 Klein et al., *supra* note 21, at 582.

182 Swart & Raes, *supra* note 8, at 297.

183 *Id.*

184 *Id.*

185 McAllister, *supra* note 23, at 2128–43.

186 *Id.* at 2129–34.

187 Ari Phillips, *World's Largest Solar Thermal Plant Uses As Much Water As Two Holes on Nearby Golf Course*, CLIMATE PROGRESS (Feb. 13, 2014), http://thinkprogress.org/climate/2014/02/13/3289361/worlds-largest-solar-plant/.

188 McAllister, *supra* note 23, at 2134–38.

189 *See, e.g.*, Trisolini, *supra* note 23, at 679–87.

by slowing indoor temperature changes during severe temperatures."[190] Similarly, cities can employ reflective materials to reduce heat stress from the urban heat island effect, which concurrently reduces air conditioning requirements and increases the earth's albedo, both of which have mitigative benefits.[191] Finally, Professor Trisolini argues that increased use of distributed renewable energy and microgrids can mitigate climate change and synchronously increase the energy system's resilience.[192]

The benefits of finding synergies include marshalling institutional and fiscal resources in a more efficient manner.[193] Additionally, the process may help bridge the conceptual gap between mitigation and adaptation.[194] This last benefit may be under-represented in the literature; indeed, by linking mitigation and adaptation conceptually during analysis, policymakers may be more likely to address the climate change problem in a comprehensive, holistic fashion as opposed to a piecemeal approach. Scholars have, however, identified risks with focusing on creating synergies.[195] The risks include the likelihood of greater institutional complexity in implementing synergistic measures, the improbability that synergistic measures can sufficiently address climate change, and the possibility for inefficient resource allocation.[196]

These concerns are certainly valid, particularly the first and third, and are discussed in greater detail in Part IV. Briefly, adaptation measures will be necessary at every level of government, and may take innumerable forms due to geographical, geologic, and social differences in the areas of implementation.[197] Consequently, it might be prohibitively expensive and time consuming to subject every adaptation decision by local, regional, and state governments, no matter how small, to detailed mitigation-adaptation analysis. Further, there may not be opportunities for meaningful synergies when adaptation measures must be carried out at a different level of government than mitigation. For instance, a small town might have its electricity rates set by the state public service commission, but receive its energy from a power generator in another state that uses transmission lines regulated by FERC. The small town might not have

190 *Id.* at 682.

191 *Id.* at 683–85.

192 *Id.* at 685–87.

193 Ayers & Huq, *supra* note 19, at 757.

194 *Id.*

195 Klein et al., *supra* note 21, at 582.

196 *Id.*

197 There are certainly areas that will have similar adaptation requirements and may implement similar adaptation measures. Nevertheless, specificities of locality will necessarily create the need for adaptation regimes that are uniquely tailored. For instance, two coastal cities may both decide on a combination of seawalls and retreat to counteract the effects of rising seas; yet due to local conditions, those cities may be required to implement those measures in completely different ratios or to different degrees.

access to the information it needs to make a complete mitigation-adaptation analysis, or if it did, might not be able to coordinate measures that require the participation of various state and federal agencies. In short, hunting for synergies might unnecessarily waste resources and only lead to minimally beneficial integrated measures. Notwithstanding the concerns, however, the substantial interaction between mitigation and adaptation warrant further exploration for synergies.

In addition to identifying synergies between mitigation and adaptation, an integrated climate policy may illuminate unintended consequences and trade-offs that result from mitigation and adaptation measures and policies.[198] Trade-offs are a "balancing of adaptation and mitigation when it is not possible to carry out both activities fully at the same time."[199] In short, trade-offs occur when funds spent on one are not available for the other.[200] Some scholars have argued that trade-offs are not inherently a problem because the actors responsible for, and beneficiaries of, mitigation are different that those who pay for and reap the benefits of adaptation.[201] Inter-generational trade-offs, however, might also be an issue, as money spent today on mitigation might not be available for adaptation later.[202] An informed approach that illuminates trade-offs might allow policymakers and planners to integrate rational decisions about trade-offs into climate change policies and laws.

Unintended consequences are simply interactions between mitigation and adaptation that produce undesired or unexpected outcomes. The increased energy usage that results from expanded distribution of air conditioning and coastal protection measures are obvious examples of unintended consequences. Another example can be seen in the tremendous amount of energy needed to funnel water to arid cities. Plans to divert more water to increasingly arid cities may unintentionally increase energy use, and thus GHG emissions. Conversely, efforts to conserve energy by reducing the amount of water that is piped over long distances might create major adaptation obstacles for well-established cities in increasingly dry areas.

Viewing decisions through a mitigation-adaptation lens provides an opportunity to examine the ways that the two climate change responses interact. Further, it arms policymakers and planners with the information necessary to identify synergies, unintended consequences, and trade-offs, which subsequently provides for a more informed decision-making process. While there are constraints on the use of an integrated approach, it nevertheless can contribute to effective climate policy.

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198 *See* Biesbroek et al., *supra* note 16, at 232.

199 Klein et al., *supra* note 8, at 749.

200 *Id.* at 751.

201 *Id.*

202 *Id.*

IV. USING A MITIGATION-ADAPTATION LENS TO CRAFT EFFECTIVE CLIMATE POLICY AND LAW

While the scholarly literature on integrated climate policies that view mitigation and adaptation in tandem is growing, the legal literature has only recently addressed this issue explicitly.[203] Instead, the majority of articles in the legal journals either focus on the two climate change responses separately or, increasingly, on how legal regimes must adapt to climate change.[204] As effective climate policy is reliant on an accommodating legal infrastructure, this Part first examines some proposed changes to legal regimes in response to climate change. It then argues that effective climate policy and law must account for the intersection of mitigation and adaptation by viewing decisions through a mitigation-adaptation lens. Further, it discusses limitations to the integrated approach. Finally, it proposes a framework for implementing the mitigation-adaptation lens.

A. Adapting Legal Regimes

Just as uncertainty complicates planning for future climate change consequences with specific adaptation measures,[205] it also presents a challenge to the legal regimes necessary to implement such measures.[206] The literature on the appropriate evolution of legal regimes in response to climate change is growing, with a particular focus on natural resources management and environmental law.[207] Although various procedures, tools, and systems have been proposed, there are issues around which some agreement is building. This Part does not attempt an encyclopedic recitation of every proposed legal reform, but rather examines a few of the proposals to illustrate current thinking and find

[203] *See, e.g.*, McAllister, *supra* note 23 (addressing adaptive mitigation in the electric sector); Trisolini, *supra* note 23 (identifying three mitigation-adaptation measures that create synergies).

[204] *See, e.g.*, Craig, *supra* note 8, at 23–28 (arguing that it is time to "turn legal attention to climate change adaptation" and away from mitigation); *see also generally*, Flatt, *supra* note 119 (providing a "protocol for adapting laws generally" in response to climate change); Doremus, *supra* note 14 (arguing that climate change demands laws that "bend without breaking") ; Ruhl, *supra* note 13 (discussing the evolution of climate change adaptation law); Daniel Schramm & Akiva Fishman, *Legal Frameworks for Adaptive Natural Resource Management in a Changing Climate*, 22 GEO. INT'L ENVTL. L. REV. 491, 491 (2010) (arguing for the incorporation of adaptive management into the legal frameworks for climate change); Camacho, *supra* note 14 (calling for a "fundamental reformation of natural resource governance" in response to climate change). Some articles do indeed recognize that mitigation and adaptation are intertwined, *see* Ruhl, *supra* note 13, at 370, but do not propose adopting an integrated approach.

[205] *See* discussion, *supra*, in text accompanying notes 158–175.

[206] *See* Doremus, *supra* note 14, at 48 (noting that "[w]e have little experience with [the] sort of law" needed to "withstand sustained pressures" while still conforming to long-term goals); Craig, *supra* note 8, at 15 ("[A]dapting law to a world of continuing climate change impacts will be a far more complicated task than addressing mitigation.").

[207] *See* articles, *supra*, note 204.

some uniting principles.

The scholarly community almost uniformly recognizes that the existing legal infrastructure is not well suited to handle the climate change problem.[208] There are many reasons why this is the case. Most importantly are the unique challenges presented by climate change: it is a massive problem that transcends political and geographic boundaries, areas of law, and traditional modes of regulation.[209] Climate change has multiple anthropogenic and natural causes,[210] and has the potential to affect every person, animal and plant, and industry on the planet. Moving forward, laws will likely be required that address every one of those causes and affected parties. The current approach to climate change is to shoehorn responses into existing regulatory regimes like the Clean Air Act, the Coastal Zone Management Act, and various state and local statutes and regulations. Those regimes were certainly not designed with climate change as a primary consideration, and none is currently constructed to properly accommodate it in a comprehensive fashion.[211]

Indeed, Professor J.B. Ruhl has noted that climate change is leading to a future that has no analog,[212] while Professor Robin Craig has declared,

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[208] *See* Doremus, *supra* note 14, at 48; Flatt, *supra* note 119, at 274 (noting that climate change will affect "contracts, property law, patent law, health law, insurance law, and banking law, to name a few . . . ."); Markell, *supra* note 14, at 43 (noting skepticism that the current structure of government is adequate to develop and implement climate change solutions); Camacho, *supra* note 14, at 7 ("Climate change necessitates a fundamental reformation of natural resource governance."); Craig, *supra* note 8, at 15; Ruhl, *supra* note 13, at 369 ("[D]rags on the formulation of our domestic climate change policy are persistent and debilitating.").

[209] *See* J.B. Ruhl & James Salzman, *Climate Change, Dead Zones, and Massive Problems in the Administrative State: A Guide for Whittling Away*, 98 CAL. L. REV. 59, 73–93 (2010) (noting that climate change is a "massive problem" that has multiple causal sources and produces multiple and cumulative effects, both of which span large temporal and spatial boundaries).

[210] *Id.*

[211] For example, the Clean Air Act is designed to regulate air pollution, a definition that includes greenhouse gases. *See* Massachusetts v. EPA, 549 U.S. 497, 532 (2007). It regulates those greenhouse gas emissions through various permitting schemes, plans, and standards that apply to stationary and mobile sources. *See* Clean Air Act, 42 U.S.C. §§ 7401 et seq. (2012). Yet it is not intended or designed to regulate increased atmospheric concentrations of greenhouse gases that result from land use decisions. Similarly, the Clean Water Act regulates water pollution through various permitting schemes. *See* Clean Water Act, 33 U.S.C. §§ 1251 et seq. (2012). The Clean Water Act is not, however, constructed to regulate the ocean acidification that results from higher greenhouse gas emissions. The Endangered Species Act was created to prevent anthropogenic threats to species threatened by extinction, and does so through a permitting scheme, prohibitions on taking species, and consultation requirements, *see* 16 U.S.C. §§ 1531 et seq., but it is not clear that the ESA—often called the "pitbull of environmental law"—has teeth enough to protect such species from the rapidly intensifying extinction threat posed by climate change. All of these laws address the effects of climate change in some way, yet none does so comprehensively; indeed, each law fails to sufficiently regulate the specific affects within the particular ambit of its statutory purpose. Further, these laws were all designed, in some way, to restore the air, water, and ecosystems to a status quo that is increasingly rendered meaningless by climate change.

[212] Ruhl, *supra* note 13, at 376.

"stationarity is dead."[213] The "no analog" future applies not just to ecosystems, but also to social systems and the legal apparatuses that regulate both the natural and social systems. Because of the inherent uncertainty of climate change, it is difficult to formulate specific laws or mechanisms now that will adequately accommodate adaptation in the future; in short, we simply do not know what the future will look like. It may be possible to make judgments now about the probable consequences of climate change and modify existing legal regimes accordingly. Nevertheless, preservationist laws that are designed to restore systems to the status quo are likely outdated, unhelpful, and potentially damaging.[214] Whether through modification of existing regimes or the creation of entirely new ones, the law will have to adapt alongside the people, industries, and natural systems it regulates.

Because of the unprecedented uncertainty surrounding climate change, the second consensus building in the literature is that legal regimes must be malleable enough to incorporate new information yet firm enough to achieve goals. In proposing malleable regimes, scholars have identified several approaches, most of which take cues from the world of adaptive management.[215] Professor Alejandro Camacho, for instance, argues for the implementation of a "learning infrastructure" at the federal level.[216] This learning infrastructure focuses on two principal components: "(1) an adaptive governance framework, which would require sustained monitoring and adjustment of regulatory decisions to assess whether such strategies further regulatory goals; and (2) an information-sharing infrastructure for collecting and circulating scientific data on natural systems and assessments of management strategies and programs."[217]

Similarly, Professor Holly Doremus proposes a shift away from rigid "oak-like" environmental laws that focus on precommitments, and to a more flexible, "wind-swept pine" model.[218] Such an approach would allow for laws that adapt to unforeseen changes, but simultaneously protect the long-term goals associated with them.[219] The "wind-swept pine" system is itself a flexible framework that could, for example, incorporate moving baselines.[220] Like other scholars,

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[213] Craig, *supra* note 8, at 15 (quoting P.C.D. Milly et al., *Stationarity Is Dead: Whither Water Management?*, 319 SCI. 573, 573 (2008)).

[214] *See* Craig, *supra* note 8, at 17

[215] *See, e.g.*, Camacho, *supra* note 14, at 39–41 ("Adaptive management is a particularly useful strategy for managing the uncertainty of climate change as it increases the ability of a natural system to absorb and respond to multiple climate change scenarios . . . . [and], many have promoted adaptive management as the most promising approach for addressing uncertainty in the face of climate change"). *But see id.* at 42 ("[P]rototypes of the use of adaptive management . . . can fall short of the ideal.").

[216] Camacho, *supra* note 14, at 9.

[217] *Id.*

[218] *See* Doremus, *supra* note 14, at 48.

[219] *Id.*

[220] *Id.* at 70–71.

Professor Doremus cautions against a system that seeks to snap back to preexisting conditions.[221]

Professor Robin Craig also recognizes the need for "a new legal framework that will allow a multiplicity of techniques to be brought to bear in crafting adaptation responses to particular local impacts while still promoting actions consistent with overall ecological and social goals."[222] Accordingly, she proposes "principled flexibility" as the overarching feature of the new framework, and offers five principles to guide adaptation law.[223] Principled flexibility would theoretically allow society to deal with uncontrollable impacts of climate change while preserving the general goals of adaptation.[224] Professor Craig warns, however, that flexibility in law cannot "become a mechanism for avoiding effective environmental regulation and natural resource management."[225] Accordingly, principled flexibility includes mechanisms to ensure that it does not lead to "abdication of all environmental regulation and management."[226]

Professor Robert Glicksman, on the other hand, proposes a framework that focuses on the appropriate level of government to implement various adaptation measures.[227] In so doing, he argues that, "collective action principles provide a useful tool for helping to determine the proper institutional arrangements for dealing with climate change adaptation."[228] Professor Glicksman concludes that federal power should be used to set floors in environmental policy to protect against states that do too much or too little in the face of climate change, and that federal preemption of state law may, in limited instances, be necessary to promote efficient adaptation.[229]

The preceding proposals, along with other similar proposals, all contemplate the uniqueness of the climate change problem and the unsuitability of current legal regimes to adequately handle it. Moreover, they argue for flexibility to accommodate the uncertain nature of the future under climate change. They fail,

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[221] *Id.* at 76–77 (noting that "[u]nder climate change, departure from historic conditions is the new normal, not a temporary aberration").

[222] Craig, *supra* note 8, at 17.

[223] *Id.* at 17. Professor Craig's principles are: #1 Monitor and Study Everything All the Time; #2 Eliminate or Reduce Non-Climate Change Stresses and Otherwise Promote Resilience; #3 Plan for the Long Term with Much Increased Coordination Across Media, Sectors, Interests, and Governments; #4 Promote Principled Flexibility in Regulatory Goals and Natural Resource Management, and; #5 Accept—Really Accept—That Climate Change Adaptation Will Often Be Painful. *Id.* at 40–70.

[224] *Id.* at 64.

[225] *Id.* at 17.

[226] *Id.* at 64.

[227] Robert L. Glicksman, *Climate Change Adaptation: A Collective Action Perspective On Federalism Considerations*, 40 ENVTL. L. 1159, 1165–66 (2010).

[228] *Id.* at 1166.

[229] *Id.* at 1193.

however, to account for the interaction of mitigation and adaptation, and do not expressly incorporate an integrated mitigation-adaptation analysis into the proposed frameworks. Indeed, the proposals continue to implicitly or explicitly separate the climate change responses philosophically and practically.[230] As argued *infra*, the failure to integrate the intersection of mitigation and adaptation into proffered adaptive frameworks leaves the proposals incomplete at best.

B. Adaptive Mitigation

The most important of the nascent legal scholarship on the integration of mitigation and adaptation comes from Professor McAllister's article, *Adaptive Mitigation in the Electric Power Sector*.[231] In her article, Professor McAllister discusses many of the issues I discuss herein: primarily, the ways in which the two climate change responses are intertwined, and the value of stripping needless boundaries between the two, at least occasionally. She then proposes a policy for adaptive mitigation that includes information sharing between public and private entities, project review in a manner similar to the requirements of the National Environmental Policy Act, and long-term planning.[232] Moreover, she discusses important practical implementations of adaptive mitigation in the electric power sector.[233]

While Professor McAllister illuminates for the first time in the legal literature some very important issues in bridging the divide between mitigation and adaptation, her proposal preemptively narrows the possible benefits of a mitigation-adaptation approach to limited situations. Primarily, she focuses on energy production, though she notes, "similar opportunities may exist in the transportation, agricultural, and forestry sectors."[234] Professor McAllister identifies mitigation opportunities that may have positive benefits for adaptation, without explicitly considering the converse. Additionally, Professor McAllister highlights the importance of planning, project review, and information dissemination, but does not provide a broader framework into which those elements can be incorporated to facilitate integrated and fully considered climate change decisionmaking. Professor's McAllister's article is a wonderful and much needed introduction to the possible benefits of an integrated mitigation-adaptation approach, but is also limited by the same fragmentation that is currently preventing a holistic, and ideally successful response to climate change. I will attempt to build on her work with a broader framework that can hopefully lead to more widespread benefits.

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230 *See, e.g.*, Craig, *supra* note 8, at 18–31.

231 *See* McAllister, *supra* note 23.

232 *Id.* at 2143–54.

233 *Id.* at 2123–43.

234 *Id.* at 2124.

C. Standing at the Intersection of Mitigation and Adaptation

Because mitigation and adaptation are inexorably intertwined, effective climate policy must always account for the intersection of the two. Such consideration does not mean that climate policy in all cases must address both mitigation and adaption in tandem,[235] but rather that effective policy and planning requires analysis of the effect of one on the other, the synergies and trade-offs that might exist, and the possibility for integrated policy to effect a better climate change response. In other words, the intersection of mitigation and adaptation serves as a lens through which policymakers and planners can view opportunities and costs that might otherwise remain hidden when viewing mitigation and adaptation separately.

A carbon tax provides an excellent opportunity to view mitigation and adaptation in tandem. If a carbon tax is implemented in the United States to help mitigate climate change, it will generate revenue.[236] The revenue generated by the tax might, in part, be used to create and maintain an adaptation fund.[237] Such a fund could assuage fears of opponents who are worried that the tax is simply a "revenue grab."[238] Communities could bid into the fund with specific adaptation projects as the extent of climate change consequences becomes clear. This kind of system might appeal to citizens more than one that simply returns small yearly rebates,[239] precisely because it philosophically binds mitigation and adaptation; indeed, humans cannot actually "see" the benefits of mitigation as they occur, but they can certainly observe the construction of seawalls, the distribution of air conditioning units, the construction of desalinization plants, the creation of more walkable communities, and the relocation of coastal populations.[240] In that way, the carbon tax's purpose evolves from simply "reduc[ing] greenhouse gases by changing behavior,"[241] to promoting a comprehensive response to the negative consequences of climate change.[242]

Conversely, carbon tax revenues that are funneled to adaptation will not be available for either price-oriented or research-and-development subsidies. This

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[235] *See* Trisolini, *supra* note 23, at 688.

[236] HSU, *supra* note 79, at 101. A cap-and-trade program that auctions its allowances also would raise revenue. *Id.*

[237] This proposal is different from one in which the revenue is used to fund research on or implementation of further mitigation measures.

[238] *See* HSU, *supra* note 79, at 101.

[239] *See id.* at 102 (noting that study participants in Vancouver were only "moderately more enthusiastic about higher gasoline taxes if the revenues were recycled back in the form of lower income taxes").

[240] For an example of a coastal population that must relocate due to the effects of climate change, *see, e.g.*, CHRISTINE SHEARER, KIVALINA: A CLIMATE CHANGE STORY (2011).

[241] *See* HSU, *supra* note 79, at 102.

[242] The same framework could be used for a revenue-generating cap-and-trade program as well.

trade-off may inhibit sufficient mitigation,[243] leading to greater climate change consequences and, consequently, the need for even greater adaptation measures in the future. Depending on the analysis, however, the trade-off may be a reasonable and warranted concession made to effect the most beneficial climate policy. The mitigation-adaptation lens does not, therefore, advocate a specific position; it merely illuminates possible synergies, tradeoffs, and unintended consequences of the carbon tax.

While the mitigation-adaptation lens is well suited for analyzing broad policy choices—like whether to implement a carbon tax or cap-and-trade approach—the integrated approach can and should also be used to analyze specific adaptation and mitigation measures. Returning to an earlier example, northern cities like Chicago will probably require greater distribution of air conditioning to offset urban heat stresses caused by rising temperatures.[244] The increased use of air conditioning will lead to increased electricity use, and probably greater greenhouse gas emissions. Without adequate mitigation, greater and greater amounts of northern cities will require air conditioning, leading to ever increasing greenhouse gas emissions if mitigation is not addressed. While it may prove most efficient to allow the mitigation and adaptation processes to proceed apace, there are quite likely synergies that can be found; for instance, public funding of air conditioning—which likely will be necessary in many cases—might also include efficiency upgrades for homes that balance out increased electricity use.

Other examples within the adaptation arena are numerous. As noted previously, water management measures that help sustain cities in increasingly arid conditions might lead to increased energy use. Indeed, the extraction, treatment, transportation, and distribution of water consume enormous amounts of energy.[245] The excess energy could again lead to greater greenhouse gas emissions, requiring further mitigation and adaptation. The lens not only exposes the problem, however, it provides a chance to find synergies and trade-offs. For instance, policies might be enacted that tie water use to utilization of renewable energy, perhaps through a water tax that raises money for distributed solar power.[246] Experts might determine that a water-tax plan is prohibitively wasteful, expensive, or unhelpful. The purpose of the mitigation-adaptation lens is not to propose the "right" solution, but merely to expose the options.

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[243] This discussion does not imply that subsidies necessarily lead to greater mitigation, or that a carbon tax alone is insufficient to spur adequate mitigation. For a more thorough discussion of the arguments for a carbon tax and its advantages vis-à-vis governmental subsidies, see generally HSU, *supra* note 79.

[244] *See* Confalonieri & Menne, *supra* note 134, at 418; Klinenberg, *supra* note 135.

[245] *See Water-Energy Connection*, EPA, http://www.epa.gov/region9/waterinfrastructure/waterenergy.html (last visited Oct. 25, 2014).

[246] This would be a unique reversal of a mitigation tax raising money for adaptation.

One last example demonstrates how an integrated view of mitigation and adaptation can be beneficial in planning and policymaking. As noted above, rising sea levels present a host of challenges for coastal planning commissions. Vastly different adaptation measures are required at different levels of sea level rise, with extremely varying costs.[247] In looking at possible measures, it is thus important to ask, "How, if at all, will this (seawall, floodproofing, beach renourishment, dyke, etc.) reduce the negative consequences of climate change?" Construction will likely require expenditure of additional greenhouse gases, though probably a comparatively nominal amount.[248] Additionally, the measure might allow a population to continue to live in an area that would be better served by abandonment, which might or might not increase GHG emissions beyond what they would otherwise be.[249] But, the sea-level adaptation measure might lead to a change in other policies—for instance, a switch from an economy based on beach tourism to one that thrives on water cargo—that subsequently result in greater emissions, or require further adaptation. In short, by viewing the adaptation measures through a mitigation-adaptation lens, the complete climate change consequences of the coastal protection measures can be properly evaluated.

An integrated view of mitigation and adaptation is not, therefore, limited to assessing broad mitigative policies like the carbon tax in hopes of finding ways to incorporate adaptation, nor will it always suggest an integrated approach. Rather, it is a means of analyzing climate response policies and measures by asking the foundational question, "How will this [mitigation or adaptation measure], in its entirety, affect the consequences of climate change?" This question is and will be critical, particularly as the effects of climate change become more pronounced and people rush to implement adaptive measures to offset the repercussions. As noted previously, without sufficient mitigation, climate change will likely exceed the adaptive capacity of many social and ecological systems. Conversely, mitigation without proactive adaptation planning could also have significantly negative consequences, primarily increased costs and deaths as the world attempts to "learn by doing."[250] Thus, even when allowing for a flexible system, it is still important to ask the question early, and often.

The foundational question applies not only to specific climate change policies

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[247] *See* discussion, *supra* note 165.

[248] Klein et al., *supra* note 8, at 759 ("Even if . . . construction projects reach massive scales, the embodied energy, and thus the associated greenhouse-gas emissions, is likely to be merely a small proportion of the total energy use and energy related emissions in most countries.").

[249] The population has to live somewhere, after all, and presumably would use GHG-causing energy in any location.

[250] "Learning by doing" is a simplified way of describing adaptive governance, or management. *See, e.g.*, Carl Folke et al., *Adaptive Governance of Social-Ecological Systems*, 30 ANNUAL REVIEW OF ENVTL. RES. 441, 448 (2005).

and measures, but also to the legal regimes that implement those policies and measures. While flexibility is a sensible approach to legal frameworks in the wake of climate change, proposed systems cannot ignore the intersection of mitigation and adaptation. Like substantive adaptation measures, legal regimes will continually be shooting at moving targets if the climate is not stabilized with substantial mitigation efforts. Anthropogenic climate change might be where adaptive governance, in addition to essentially everything else, fails to offer predictable or consistent results. Not only is there little chance of snapping back to a preconceived stationarity, there is essentially a guarantee of future uncertainty so long as mitigation does not occur. Adaptive governance thus makes sense when there is some chance of a return to something akin to normalcy, even if it is an entirely new normal,[251] but it might lead to never-ending evolution if it is not paired with mitigation and pre-planning.

Further, legal frameworks that exclusively focus on adapting to climate change might fail to identify opportunities to improve mitigation. Mitigation may be a "simpler" policy problem than adaptation[252]—one that seemingly has answers, but no political will—but it would be folly to assume that the legal and scientific communities have identified all, or even the best policies and measures for mitigation. It is therefore crucial in crafting and modifying adaptive legal frameworks to ask how those frameworks operate, whether adaptation to climate change should be the only goal, and whether an integrated approach can illuminate opportunities and unintended consequences within the framework to better combat climate change.[253]

While legal scholarship on adaptation has grown tremendously in recent years, it has only begun to examine the intersection of mitigation and

[251] Indeed, Professor Ruhl's proposal for the structural transformation of climate law explicitly relies on the premise that "at some point, probably many decades into the future, the mitigation measures will gain traction on greenhouse gas emissions and will arrest further climate change to lead us into a new stabilized climate regime." *See* Ruhl, *supra* note 13, at 375.

[252] Craig, *supra* note 8, at 28.

[253] For instance, tort law—like essentially all areas of law—will have to adapt to incorporate climate change consequences. Indeed, the evolution of tort and property law in relation to nuisance and climate change has been occurring for some time. *See generally, e.g.*, Douglas A. Kysar, *What Climate Change Can Do About Tort Law*, 41 ENVTL. L. 1 (2011); Randall S. Abate, *Automobile Emissions and Climate Change Impacts: Employing Public Nuisance Doctrine as Part of a "Global Warming Solution" in California*, 40 CONN. L. REV. 591 (2008); Ken Alex, *A Period of Consequences: Global Warming as Public Nuisance*, 43A STAN. J. INT'L L. 77 (2007). As the tort regime goes through the common law and legislative process, it will always be important to ask, "How will this [ruling, bill proposal] reduce the consequences of climate change in its entirety?" Clearly, judges are not, and should not, be tasked with asking such a broad question when formulating opinions. Rather, the question should be asked of judicial opinions to help guide future litigation or legislation. In so doing, policymakers might, for instance, discover that specific causes of action succeed from an adaptation standpoint in addition to a mitigation standpoint, or conversely, benefit adaptation at the expense of mitigation.

adaptation.[254] In exploring the relationship between the two climate change responses, however, it is also important to acknowledge the limitations of using the mitigation-adaptation lens.

a. Limitations

While implementation of the mitigation-adaptation lens into policymaking and planning can help ensure more thoughtful and effective responses to climate change, there are inherent limitations in the approach. Notably, adaptation is likely to be necessary at every level of government; most importantly, local governments will probably implement many, if not the majority, of adaptation measures.[255] As noted above, it might be impractical, from both a cost and time perspective, to subject every adaptation decision at the local level to an integrated analysis. First, local planners and policymakers lack the tools and resources to properly assess each decision with a comprehensive mitigation-adaptation approach. Second, some adaptation decisions will almost assuredly present insufficient synergistic opportunities,[256] and municipalities may waste precious time researching to an inevitably fruitless outcome. Third, opportunities for synergy may be limited due to institutional complexity.[257] For example, even if a municipality identifies an opportunity for synergy in relation to a proposed adaptation measure, it may prove impracticable to coordinate with the appropriate state or federal actors and private stakeholders necessary to achieve that synergy.[258] While these challenges are particularly problematic for local governments, they also apply to state and federal decisions.

Hunting for synergies may therefore be an unproductive and wasteful endeavor. One scholar has even argued that, "it is doubtful that sufficient opportunities for synergies can be identified to achieve the levels of mitigation and adaptation deemed required."[259] As such, it might be more productive to simply channel funds to mitigation and adaptation separately.[260] Others have noted, however, that simply addressing mitigation and adaptation in tandem can reduce the conceptual divide between the two and "empower the adaptation agenda."[261] Similarly, the process of viewing climate change responses through the mitigation-adaptation lens to illuminate the interactions between the two might spur the creation of comprehensive climate change policies—at the state, regional, and federal level—under which climate change laws are not

254 *See, e.g.*, McAllister, *supra* note 23; Trisolini, *supra* note 23.

255 *See* Biesbroek, *supra* note 16, at 232.

256 Klein et al., *supra* note 21, at 582.

257 *Id.*

258 *See id.*

259 *Id.*

260 *Id.*

261 Ayers & Huq, *supra* note 19, at 757.

fragmented across dozens of legal regimes. Indeed, exhaustive climate change policies that eliminate the segmentation of responses into distinct and unrelated statutory and regulatory regimes—and the accompanying diversity of state and federal agencies—would assuage some of the institutional complexity that hinders the efficacy of an integrated approach.

There are limitations on adopting the mitigation-adaptation lens into rational climate policy. Nevertheless, the benefits urge the incorporation of the lens into policymaking and planning to at least expose the possible synergies and trade-offs that exist. Accordingly, the proposed framework for the integration of the mitigation-adaptation lens implicitly or explicitly addresses limitations. Once opportunities and consequences are highlighted, and limitations reduced, leaders can make informed decisions about whether to utilize integrated approaches to the combat the consequences of climate change.[262]

V. A PROPOSED FRAMEWORK FOR IMPLEMENTING THE MITIGATION-ADAPTATION LENS

While further research on the integrated approach to climate change is certainly needed, this Article builds on Professor McAllister's work and proposes a basic framework from which to begin the broad implementation of the mitigation-adaptation lens into policymaking and planning. The Framework combines pre-planning with the flexibility of adaptive management in a centralized yet cooperative agency. More importantly, it provides a guide to the actual process of using the lens to analyze policy. This Part describes the framework proposal generally and gives examples of how it can be used.

The framework has four primary parts. First, research into integrated approaches to climate change mitigation and adaptation should be performed through cooperative federalism between local governments, states, and the federal government, and overseen by a centralized and dedicated federal agency or commission. Second, the agency will perform a "differential diagnosis" of sorts; first, the agency will ask the foundational question presented above, "How will this [mitigation or adaptation measure or policy], in its entirety, affect the consequences of climate change?" Follow-up questions will then be used to probe the interactions between mitigation and adaptation, and highlight potential synergies, unintended consequences, and trade-offs. Third, model policies, measures, and legal reforms should be crafted and then provided to governments at every level; the governments can then adopt, modify, or reject the models as necessary. If the government entities participate in the program and adopt model

[262] At least one scholar argues that integrated approaches should not only be considered, but should be categorically implemented in some instances. *See* Trisolini, *supra* note 23, at 679-80 ("Approaches that synthesize climate change adaptation and mitigation should receive *highest priorities* for funding and implementation.") (emphasis added).

responses, as tailored to the area, the federal government will provide funding. Finally, monitoring and updating requirements should be used to ensure that the model responses accurately incorporate and respond to uncertainties.

This framework is intended solely to outline a possible approach to cohesively investigating the intersection of mitigation and adaptation. It can be modified and used under existing legal regimes, incorporated into modified legal regimes, or serve as the primary tool used to coordinate climate change responses.

A. Cooperative Federalism and Information Gathering

The first element of the framework calls for a dedicated federal mitigation-adaptation research agency or commission—which for simplicity is called the MARA herein—to oversee and coordinate the research of policies, laws, and measures that implicate climate change mitigation, adaptation, or both.[263] The MARA could easily be situated within an existing agency or executive entity, such as the Interagency Climate Adaptation Task Force, the Task Force on Climate Preparedness and Resilience, or the U.S. Global Change Research Program.[264] And in a nod to the intersection, the MARA and its associated projects might be funded through an initially minimal carbon tax. In addition to coordinating research through a mitigation-adaptation lens, the MARA would also help unify the federal response to climate change into a single entity with expertise on many aspects of climate change. In short, it would begin eliminating the mitigation-adaptation dichotomy by removing the philosophical and practical divides that currently separate the two climate change responses.

Climate change will affect countless local, state and federal actors, industries and businesses, and geographic areas. The MARA will be in a position to coordinate and interact with these various stakeholders, and collect and consolidate the information provided. Such interaction is crucial, as different stakeholders are naturally more informed about certain areas of climate change impacts, while less informed about others. As different localities will have

[263] While called the MARA in this Article, the agency ideally would not, even in its title, differentiate between adaptation and mitigation. Instead, it would be a genuine Climate Change Response Administration that would have authority to collect and share information on climate change responses, including the mostly segregated energy industry.

[264] These various task forces and programs evidence two things: first, that even within the White House, the response to climate change is unnecessarily fragmented by philosophy and sector, and; second, that large-scale energy production is divorced from the federal government's climate efforts. As noted previously, the mitigation-adaptation dichotomy contributes to unnecessary structural impediments between the various entities researching climate change, its impacts, and responses. Of particular note is that none of the task forces has much authority to investigate and coordinate with the energy industry. The task forces are thus working on the periphery of adaptation while substantive mitigation of GHGs from the energy sector is relegated to the EPA through the mismatched Clean Air Act.

different needs, particularly when it comes to adaptation, the MARA can delegate the gathering and analysis of state- and locale-specific information to participating state agencies. By coordinating the entire process and communicating with relevant federal and state agencies, the MARA will help government actors traverse the tangled nest of institutional complexity. Moreover, it can survey the range of adaptation and mitigation options to ensure that unique approaches by one locality do not go unseen by other localities that could benefit. Finally, it can coordinate the collection of state concerns regarding national climate change responses.[265]

The states would of course have to voluntarily comply with the MARA and its program. The primary carrot offered the states would be funding from the MARA to implement climate change responses. Additionally, states would be able to save money on researching adaptation and mitigation strategies, and would benefit tremendously from shared knowledge. Some states would no doubt hesitate to offer critical information with other states and the federal government. Moreover, some states may feel that the cost-benefit ratio of participating would tilt against participation. If, however, the MARA was funded by a federal carbon tax, it would be difficult to envision a state not welcoming some of the benefits of the proceeds.

It may seem overwhelming for one commission to oversee all research into mitigation and adaptation options to find possible synergies and unintended consequences, and indeed it might be. Nevertheless, extensive research into mitigation and adaptation is already happening, at every level of government, and by numerous agencies and other government entities. Consolidating the research into one entity may save time and money, and additionally, it would create a single entity with vast expertise in climate change mitigation and adaptation. That expertise could be utilized by any number of federal, state, and local government actors to ensure a coordinate and rational response to climate change. Indeed, the expertise would extend to all areas of mitigation and adaptation, and not just the intersection of the two. Further, a centralized information commission would help reduce duplicitous research, and facilitate information sharing amongst agencies. However, if the idea proves either too untenable or unrealistic, the framework can still succeed by eliminating the first step and moving the remaining steps into, for instance, a state climate change commission.

[265] As noted by Professor McAllister and others, providing for climate change refugees will likely become a national issue in the future. While the federal government has plenary authority over immigration, it would nevertheless be beneficial to coordinate with state and local governments to develop a strategy that does not offset local mitigation and adaptation efforts, while simultaneously gathering input about the unique difficulties faced by sub-federal governments.

B. Differential Diagnosis - Searching for Synergies and Trade-offs

Once it has gathered information about an adaptation or mitigation measure, policy, or law, the MARA will perform a "differential diagnosis"[266] to identify the net effect of the response and to reveal possible synergies, unintended consequences, and trade-offs. First, it will ask how the climate change response in its entirety will affect the consequences of climate change. This intuitively and intentionally simple process is designed to highlight the interactions between climate change mitigation and adaptation—indeed, it is the failure to ask that basic question that might lead to unnecessarily segmented or misguided climate change responses.[267] The foundational question generates subsequent questions to parse out the exploratory path. Planning and scientific analyses focused on an interdisciplinary approach are then used to answer the questions. By using sequentially probing questions and analysis, the MARA can identify interactions between mitigation and adaptation measures and policies.[268]

The framework applies to the reform or creation of laws that affect or are affected by climate change, such as the CAA, just as it does to specific adaptation and mitigation measures.[269] Regarding the CAA, the first question is, of course, how does the CAA in its entirety affect climate change consequences? It clearly has mitigative properties: as noted above, the CAA authorizes regulation of greenhouse gas emissions from mobile and stationary sources.[270] But how will the implementation of those policies interact with adaptation? If, for example, the EPA successfully implements its proposed rule for GHG limitations at new power plants, how will that rule affect other mitigation or

[266] In medicine, a differential diagnosis is used to systematically distinguish diseases with similar symptoms. *See* Differential Diagnosis, Dictionary.com, http://dictionary.reference.com/browse/differential+diagnosis (last visited Oct. 25, 2014). Here, it is used in the reverse to describe a systematic process of identifying the full range of "symptoms" that may result from a "treatment."

[267] While not necessarily a climate change mitigation measure, the promotion of corn ethanol as a cleaner fuel is one such misguided policy. *See* David J. Murphy & Charles A. S. Hall, *Year in Review—EROI or Energy Return on (Energy) Invested*, 1185 ANNALS OF THE N.Y. ACAD. OF SCI. 102, 114-15 (2010) (noting that because of its low or even negative EROI, corn ethanol is "not energetically or economically competitive or perhaps even viable").

[268] For instance, the MARA would explore how various measures to adapt to sea-level rise would affect climate change consequences. How does a plan to build larger seawalls affect surrounding areas? Will it generally encourage continued or expanded occupation of the area by citizens and businesses? If so, would that occupation require greater energy to support the population? If seawater inundates local drinking supplies, continued occupation may require desalinization, or the import of water from great distances, both of which would require increased energy use. How would the energy be generated? Would the seawall contribute to disappearing beaches that require renourishment, or would the area abandon any beaches to the sea? How would that affect local industry, commerce, and species?

[269] Analysis of existing statutes and regulations is crucial as "[a]daptation assessment may be most needed in situations where no proposed action is pending, but the agency needs to be more proactive." Daniel A. Farber, *Adaptation Planning and Climate Impact Assessments: Learning from NEPA's Flaws*, 39 ENVTL. L. REP. NEWS & ANALYSIS 10605, 10605 (2009).

[270] *See* discussion, *supra*, accompanying notes 84–95.

adaptation policies? Perhaps the rule will further spur the adoption of natural gas as the fuel of the future—if energy companies feel comfortable that the regulations provide stability—and edge out renewable energy projects. In turn, the use of natural gas instead of renewable energy projects could prevent conservation of water resources.[271] A law designed to mitigate climate change could thus perversely negate its own mitigative potential while simultaneously increasing the challenges of adaptation. Or, the proposed rule might prevent the construction of newer coal power plants yet encourage the continued use of older grandfathered plants.[272] The resulting emissions of other pollutants from the older, dirtier plants might exacerbate public health problems caused by climate change, complicating adaptation measures. Similarly, increased fuel mileage standards might lead to cheaper travel costs as cars travel further with less gas. Subsequently, people may change their driving habits to drive more, or to live farther from work, offsetting emissions reductions from the increased mileage standards.[273]

These questions simply expose any interactions between mitigation and adaptation. In so doing, the process creates the opportunity to explore synergies and trade-offs that might exist. The analysis thus shifts from exposing interactions to identifying synergies and trade-offs in order to find the optimal integration, if any, of mitigation and adaptation. For instance, if it is determined that building a seawall under certain coastal conditions will lead to expanded population growth in an area and subsequently increased energy use in providing potable drinking water, the seawall initiative might reasonably be accompanied by land use regulations that prohibit lawn watering. Or, it might be accompanied by increased property tax that, after completion of the wall, is used to finance distributed renewable energy that offsets the increased energy use. Similarly, the policymakers might pair the seawall with incentives to encourage conservation and efficiency by the local public. Even more optimistically, it may be possible to couple the seawall with emerging wave-power technologies to generate energy. On the other hand, the MARA may decide that there are no meaningful synergies to be found, but that the trade-offs do not preclude building the seawall. Or, the MARA may conclude after analysis that the unintended consequences of the seawall are too burdensome on mitigation and that insufficient synergy opportunities exist, and opt instead to recommend other coastal infrastructure protection measures, such as retreat. In the case of the

[271] *See* McAllister, supra note 23, at 2128–34.

[272] Brad Plumer, *Why the EPA Might Delay Its Carbon Rules for Power Plants*, WASH. POST. (March 18, 2013), http://www.washingtonpost.com/blogs/wonkblog/wp/2013/03/18/why-the-epa-might-delay-its-carbon-rules-for-power-plants/.

[273] *See, e.g.*, Jonathan Karp, *Suburbs a Mile Too Far for Some*, WALL ST. J. (June 17, 2008), http://online.wsj.com/article/SB121366811790479767.html (noting that suburban expansion is predicated partly by the affordability of driving).

CAA, there may be opportunities to promote conservation measures alongside higher mileage standards, such as an incentive program that rewards drivers for driving fewer miles in a year. Or, it may be that the unintended consequences of the mileage standards (e.g. more driving) are not prohibitively onerous; in that situation, the increased driving might be a warranted consequence.

Finally, examining the CAA under the mitigation-adaptation lens might reveal, at least to those who have yet to see it, that the CAA is an entirely inefficient and piecemeal approach to climate change mitigation. Under such a scenario, simply breaking through the mitigation-adaptation dichotomy might lead to calls for a superior, unified domestic climate change policy. Until the ideas are fully explored, however, the range of climate change consequences of the CAA will not be clear.

To reiterate, the purpose of asking first the foundational question and then the follow up questions is simply to expose and explore the various intersections of mitigation and adaptation to determine if those intersections lead to opportunities, or unintended consequences. Once those possible synergies and trade-offs are explored, the MARA can develop suggestions for the most beneficial way to proceed. In short, it ensures that climate change responses are holistically reasoned and deliberative.

C. Providing Model Approaches and Funding

The MARA, upon completion of its analyses, will provide information to the relevant government entities. Information would be presented to governments in the form of model adaptation and mitigation responses, paired with suggested reformations to existing or proposed legal regimes to implement the responses. This information sharing approach will help local municipalities incorporate the best available information into planning and policymaking without having to expend the time and resources requisite to such an undertaking.[274] Further, model policies will allow states, regions, and the federal government to coordinate responses more effectively, which should lessen the burden posed by institutional complexity. The models can be posted online to serve as public education, which may incidentally spur greater interest in both mitigation and adaptation. Finally, the MARA will provide funding for climate response strategies that are consistent with the model approaches as necessarily modified for the specific locale.

[274] *See* Camacho, *supra* note 14, 65–70 (discussing the necessity for improved intergovernmental information sharing).

D. Monitoring and Follow-Up

To ensure that the analyses are correct, or at least unfolding as hoped for, the states and the MARA would need to continually monitor the implementation of model responses and update them as necessary.[275] This last step is especially crucial due to the uncertainty surrounding mitigation, discussed *supra* Part III.a. A "learning by doing" approach here will help to ensure that governments do not become locked into individual approaches, and that climate changes responses are robust and varied.[276]

By analyzing every mitigation and adaptation measure, policy, and law through this framework, policymakers and planners can ensure that opportunities are not routinely missed, and that any unintended consequences are accounted for or avoided. In so doing, the framework assures a more reasoned and effective response to the consequences of climate change.

CONCLUSION

The world is undergoing a geologically rapid climate transformation as the result of humankind's actions—primarily the emission of tremendous quantities of greenhouse gases into the atmosphere and the alteration of natural carbon sinks. Regardless of the changes that society makes in mitigating the problem, inertia in both human and natural systems assures that further warming of the planet will occur. Because of this future warming, humanity will need to adapt to climate change to ensure the survival of species, ecosystems, and social systems.

For many years, the scholarly literature focused primarily on mitigation. Recently, however, scholars have placed considerably more focus on adaptation as it becomes clearer that some amount of adaptation will be necessary notwithstanding mitigation. The possible integration of mitigation and adaptation, however, has received comparatively scant treatment in the academic literature, and even less in the legal literature. Instead, scholarly work has primarily analyzed mitigation and adaptation as distinct climate change response choices; some of the work has treated the concepts as competing choices, while others acknowledge the interrelation of the two without explicitly taking an integrated approach. The legal literature that has addressed the integrated approach to climate change responses has provided examples, but has not put forth a means of incorporating an integrated approach into climate change decisionmaking generally. Without such a framework, climate change responses may be incomplete, misguided, or even destructive.

This Article proposes a framework for viewing climate policy and law

[275] *See* Craig, *supra* note 8, at 40–43 (noting the need to "Monitor and Study Everything All the Time").

[276] *See* Farber, *supra* note 269, at 10612–13.

through a mitigation-adaptation lens. This proposal is not necessarily meant to supplant existing or propounded frameworks for climate policy and law—though in some instances that may be warranted—but rather to supplement and improve those frameworks. By viewing suggested climate change responses from the intersection of mitigation and adaptation, planners and policymakers can better identify problems, opportunities, and costs that might otherwise go unnoticed, and craft more reasoned and effective climate policies, measures, and laws.