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Local Land Use Power: Managing Human Settlements to Mitigate Climate Change

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SUMMARY

Local land use law has evolved into a flexible and powerful technique for achieving sustainable development. This Article, adapted from Chapter 3 of *Choosing to Succeed: Land Use Law & Climate Control* (ELI Press 2021), looks at the authority and strategies that enable municipalities to lower their carbon footprint. It describes and analyzes many methods, both traditional and innovative, to use the power of local governments to reshape human settlements to mitigate climate change. The Article demonstrates that land use regulation can be retooled to greatly reduce or capture urban carbon emissions, and posits that mitigation efforts can lead to significant adaptation benefits, linking the two components of climate change management.

I. Low-Carbon Land Use: A Natural Evolution of Local Practice

In 2014, the world caught up with local governments in the global race against climate change. That year, the Intergovernmental Panel on Climate Change (IPCC) embraced the critical role of municipal governments in mitigating the causes of climate change.[1] In 2015, the Paris Climate Agreement adopted by the Conference of the Parties (COP) followed suit.[2] In 2019, the IPCC renewed its support for local mitigation as a key complement to global climate goals and initiatives.[3]

For decades, the legal and practical ability of municipal governments to shape human settlements in ways that lower carbon dioxide (CO_2) emissions and enhance biological sequestration has been clear to land use practitioners. The recognition of a key role for the grassroots level of government is consistent with an impressive body of theoretical work by scholars who focus on the relative competencies of various levels of government, the functioning of complex adaptive systems, institutional networks, and the dynamics of social change.

Notwithstanding this practical progress and these strong theoretical underpinnings, until recently the role of local governments in mitigating climate change was largely ignored internationally. Global leadership concentrated instead on top-down solutions, principally under the Kyoto Protocol adopted by the COP in 1997.[4] These annual COP meetings are organized under the United Nations Framework Convention on Climate Change (UNFCCC), an international environmental treaty adopted in 1992.[5] The framework it developed had little room for local climate change mitigation initiatives.

This was an unfortunate oversight. Not only do municipal governments have extensive legal authority to reduce CO_2 emissions, but their leaders are highly motivated to avoid the on-the-ground consequences of our changing climate.[6] The effects of climate change manifest themselves

1. *See generally* Karen C. Seto & Shobhakar Dhakal, *Human Settlements, Infrastructure, and Spatial Planning*, *in* Climate Change 2014: Mitigation of Climate Change (O. Edenhofer et al. eds., 2014), https://archive.ipcc.ch/pdf/assessment-report/ar5/wg3/ipcc_wg3_ar5_chapter12.pdf.
2. *See What Is the Paris Agreement?*, U.N. Climate Change, https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement (last visited Aug. 14, 2020).
3. Climate Change and Land, IPCC (2019), https://www.ipcc.ch/site/assets/uploads/2019/08/Fullreport-1.pdf.
4. Kyoto Protocol to the United Nations Framework Convention on Climate Change, Dec. 10, 1997, 2303 U.N.T.S. 162.
5. *Status of Ratification of the Convention*, UNFCCC, https://unfccc.int/process-and-meetings/the-convention/status-of-ratification/status-of-ratification-of-the-convention (last visited Aug. 14, 2020).
6. *See* U.S. Global Change Res. Program, Climate Science Special Report: Fourth National Climate Assessment, Vol. I, at 10, 12, 15 (D.J. Wuebbles et al. eds., 2017), https://science2017.globalchange.gov/downloads/CSSR2017_FullReport.pdf (The U.S. Global Change Research Program (USGCRP) released its "Climate Science Special Report: Fourth National Climate Assessment, Volume I" on the science of climate change in 2017. According to this report "it is *extremely likely* that human influence has been the dominant cause of the observed warming since the mid-20th century. For the warming over the last century, there is no convincing alternative explanation supported by the extent of the observational evidence."

> The last few years have also seen record-breaking, climate-related weather extremes, the three warmest years on record for the globe, and continued decline in arctic sea ice. These trends are expected

at the local level, where people are killed or injured, property is destroyed, businesses are shuttered, ecosystems are fouled, and where our democratic system is most vibrant.[7] The Land Use Law Center's on-the-ground experience demonstrates the proximity of government decisionmakers to the practical problems caused by climate change.

To illustrate, upon our discovery of the advent of local environmental law 20 years ago, we investigated why particular localities adopted these new laws. Through interviews with local leaders, we found they were profoundly perturbed by drinking water pollution, species disappearance, riverbank erosion, wetlands damage, and the loss of historic view sheds, to name a few. These influences motivated local leaders to create and implement grassroots solutions, such as adopting local environmental laws.[8] Their reaction to the devastating effects of climate change is similar to each other's and explains why local governments have become involved. This progress is the natural evolution of a century-old legal system that has constantly innovated as new and profound changes in society have occurred.[9]

This Article on low-carbon land use describes, organizes, and clarifies strategies that local governments are employing, using their state-delegated powers to plan community development and to regulate private building, determining in the process where and to what extent our natural landscapes are developed or conserved. In all 50 states, local governments have the legal power to shape human settlements and, in so doing, lower CO_2 emissions from buildings and vehicles, increase the sequestration of carbon by the natural environment, and promote distributed energy systems and renewable energy facilities that lower fossil fuel consumption.[10]

The underlying theories supporting localism in this context are explored in Part II. These include the successful workings of complex adaptive systems, including human communities and their governments: theories that help us understand the importance of grassroots efforts to respond to contemporary challenges.[11] This Part refers to scholars of governmental policy who examine the importance of local communities drawing on concepts such as polycentricism, subsidiarity, and relative competencies. Sociologists, as students of social change, describe how innovations are adopted in human communities, observing that systemic change occurs primarily from the ground up, not from the top-down. None of these theories diminish the critical importance of higher levels of governments in addressing climate change, but they strongly urge that state, federal, and international governments effectively embrace the local role in creating their own regulatory and spending strategies.

Part III explores the recent movement at the international level to recognize the importance of local governmental strategies in mitigating climate change.[12] After discovering emerging literature on the practical successes of local governments in shaping human settlements in ways that lower emissions of CO_2, the IPCC added a chapter devoted to its importance in its Fifth Assessment Report on Climate Change, issued in 2014.[13] Notably, five years after this publication, the IPCC again stressed the value of multi-level mitigation in its Special Report on Climate Change and Land.[14] One year after the publication of the Fifth Assessment Report, the COP in Paris adopted a protocol that includes the role of local governments in contributing to mitigation through nationally determined contributions (NDCs).[15]

The details of how local land use law has been used to shape human settlements are discussed in Part IV, which demonstrates how those efforts can lower the demand for energy generated by fossil fuels as a powerful antidote to climate change.[16] Local laws and their enforcement determine how many vehicle miles are driven, how much energy buildings consume, and how natural resources that capture CO_2 through biological sequestration can be preserved and enhanced.

Part V combines five strategies into a land use stabilization wedge.[17] These local strategies demonstrate how human settlements can be shaped in ways that affect about 70% of CO_2 emissions or the means of recapturing them.[18] The components of this wedge are buildings, trans-

to continue in the future over climate (multi-decadal) time-scales. . . . Global climate is projected to continue to change over this century and beyond. The magnitude of climate change beyond the next few decades will depend primarily on the amount of greenhouse (heat-trapping) gases emitted globally and on the remaining uncertainty in the sensitivity of Earth's climate to those emissions (*very high confidence*).

7. *See* David Brooks, *The Localist Revolution*, N.Y. Times, July 19, 2018:
> [U]nder localism, the crucial power center is at the tip of the shovel, where the actual work is being done. Expertise is not in the think tanks but among those who have local knowledge, those with a feel for how things work in a specific place and an awareness of who gets stuff done.

https://www.nytimes.com/2018/07/19/opinion/national-politics-localism-populism.html.

8. *See* John R. Nolon, *In Praise of Parochialism: The Advent of Local Environmental Law*, 26 Harv. Env't L. Rev. 365, 412 (2002).

9. *See* John R. Nolon, *Zoning's Centennial: A Complete Account of the Evolution of Zoning Into a Robust System of Land Use Law—1916-2016 (Part I)*, 39 Zoning & Plan. L. Rep. 1 (2016), http://digitalcommons.pace.edu/lawfaculty/1036/; John R. Nolon, *Zoning's Centennial: A Complete Account of the Evolution of Zoning Into a Robust System of Land Use Law—1916-2016 (Part II)*, 39 Zoning & Plan. L. Rep. 1 (2016), http://digitalcommons.pace.edu/lawfaculty/1037/; John R. Nolon, *Zoning's Centennial: A Complete Account of the Evolution of Zoning Into a Robust System of Land Use Law—1916-2016 (Part III)*, 39 Zoning & Plan. L. Rep. 1 (2016), http://digitalcommons.pace.edu/lawfaculty/1038/; John R. Nolon, *Zoning's Centennial: A Complete Account of the Evolution of Zoning Into a Robust System of Land Use Law—1916-2016 (Part IV)*, 40 Zoning & Plan. L. Rep. 1 (2017), http://digitalcommons.pace.edu/lawfaculty/1039/ [hereinafter Zoning's Centennial].

10. *See infra* Part IV.

11. *See infra* Part II.

12. *See infra* Part III.

13. *See* Seto & Dhakal, *supra* note 1.

14. *See* Climate Change and Land, *supra* note 3.

15. *What Is the Paris Agreement?*, *supra* note 2.

16. *See infra* Part IV.

17. *See infra* Part V.

18. *See* U.S. EPA, Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2015, at ES-10, fig. ES-7, ES-11 (2017) (EPA 430-P-17-001) [hereinafter EPA Greenhouse Gas Inventory 2015]; U.S. EPA, Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2012, at ES-20 (2013) [hereinafter EPA Greenhouse Gas Inventory 2012]. *See also infra* text accompanying notes 102, 127, and 138.

portation, sequestration, distributed energy, and renewable energy.[19] Local land use law in most states empowers municipalities to implement strategies with respect to all of these components.

Part VI describes the corollary adaptation benefits of these strategies, including creating resilient neighborhoods that both mitigate and adapt to climate change.[20] These adaptation benefits provide further evidence of the need to fully integrate the legal powers of local governments into the national framework of laws. Local governments, as it turns out, have the power to manage climate change by adopting both mitigative and adaptive policies, plans, and programs. This reality explains why localism is being endorsed by international policies such as the IPCC Assessment Report and the Paris Agreement.

The Article concludes in Part VII, noting that if these strategies are encouraged and assisted by state and national governments, they can contribute significantly to global efforts to reach international climate change goals.[21]

II. A Theoretical Understanding of Grassroots Power

Scholars of many stripes endorse grassroots strategies for confronting many of society's problems. This can surprise some, who are trained to think mostly about top-down efforts adopted by the U.S. Congress and enforced by federal agencies. Yale law professor Robert C. Ellickson, for example, warns against the "Yale disease," which he calls the propensity of his students to look entirely to federal laws and federal courts for solutions, causing them to ignore or not understand state and local solutions.[22] He refers to the "principle of subsidiarity," "which holds that responsibility for dealing with a problem should be delegated to the most decentralized institution capable of handling that problem."[23]

Professor Ellickson's notions are supported by Dr. Elinor Ostrom, a Nobel Laureate in economics, who advanced a polycentric approach to governance.[24] She warns against the "panacea trap,"[25] which is akin to the Yale disease. A panacea trap occurs where responsible actors believe there is a cure-all solution applicable to every environmental issue, regardless of the local circumstances. She too would assign key decisionmaking responsibility to those who are as close as possible to the scene of relevant events and to the actors involved.

Law professor I. Michael Heyman, with whom we met when we founded the Land Use Law Center 26 years ago, headed the Smithsonian Institution at the time and was known to us as a former Professor of Law and of City and Regional Planning at Berkeley and former Chancellor of the University of California. We had just completed a study of the sustainability of the Hudson Valley Region and were deeply concerned about the damage to natural resources caused by sprawl, a result of land use plans and zoning adopted by over 200 constituent local governments. He suggested that to foster sustainable human settlements, we build interconnected networks of local land use leaders, as he and others had done with the several communities that share land use jurisdiction in the San Francisco Bay area.

Nobel Laureate in physics Dr. Murray Gell-Mann attended our meeting with Professor Heyman. He had just been dubbed the "man who knows everything" by the *New York Times*.[26] Dr. Gell-Mann helped to establish the Santa Fe Institute,[27] was on the board of the MacArthur Foundation, and had just published his book on sustainability, *The Quark and the Jaguar*.[28] As a physicist, he based much of his thinking on the functions of "complex adaptive systems" in nature and human communities.[29] His writings focused on how ecological systems and human communities adapt to stress and crises.

Gell-Mann discovered that healthy systems are divided into components that communicate regularly and rapidly to sense impending threats and to determine how to respond effectively.[30] In our meeting, both he and Professor Heyman pointed out that the land use boards within the typical local government are not communicating effectively and that their members need to be trained to do so. Similarly, they noticed that local governments which share regional challenges, such as sprawl, do not plan together and thus have difficulty perceiving the threats and developing strategies for responding.

All change related to land use manifests itself at the local level, and it is there that land use plans and regulations need to be changed to reorder human settlements. Change can be understood through multiple lenses, including the view of sociologists who study how change happens. One

19. *See infra* Part V.
20. *See infra* Part VI.
21. *See infra* Part VII.
22. Robert Ellickson, Losing Ground: A Nation on Edge, 275 (John R. Nolon & Daniel B. Rodriguez eds., 2007).
23. *Id.* at 274; *see also* Brooks, *supra* note 7 ("Localism is the belief that power should be wielded as much as possible at the neighborhood, city and state levels.").
24. Elinor Ostrom et al., *Going Beyond Panaceas*, 104 PNAS 15176, 15176 (2007).
25. *Id.* at 15177.
26. David Berreby, *The Man Who Knows Everything: Murray Gell-Mann*, N.Y. Times, May 8, 1994, https://www.nytimes.com/1994/05/08/magazine/the-man-who-knows-everything-murray-gell-mann.html.
27. *See generally* Mitchell M. Waldrop, Complexity: The Emerging Science at the Edge of Order and Chaos 12 (1992) (providing details of the work conducted by the Santa Fe Institute on the science of complexity).
28. Murray Gell-Mann, The Quark and the Jaguar: Adventures in the Simple and Complex 17 (1994).
29. *Id.* at 17:

> A complex adaptive system acquires information about its environment and its own interaction with that environment, identifying regularities in that information, condensing those regularities into a kind of "schema" or model, and acting in the real world on the basis of that schema. In each case, there are various competing schemata, and the results of the action in the real world feedback to influence the competition among those schemata.

See also Thomas L. Friedman, *Where American Politics Can Still Work: From the Bottom Up*, N.Y. Times, July 3, 2018: ("Our country is actually a checkerboard of cities and communities—some that are forming what I call 'complex adaptive coalitions' and are thriving from the bottom up."). https://www.nytimes.com/2018/07/03/opinion/community-revitalization-lancaster.html.
30. Gell-Mann, *supra* note 28, at 17.

term for what they observe is the "diffusion of innovation," a term which was popularized by Dr. Everett Rogers.[31] Diffusion, he notes, includes the planned and spontaneous spread of new ideas, such as methods of containing sprawl, or implementing measures to mitigate climate change.

We adopted Dr. Rogers' notions in establishing the Land Use Alliance Leadership Training Program and recruiting local "champions of change," as he labels them,[32] to attend our training programs. We learned from Dr. Rogers that change happens when local champions reach out beyond their jurisdictions to peers and respected change agents to solve local problems, so we brought these resources into our training programs. By training these leaders and exposing them to potential adaptations, we taught them to connect locally and regionally, building on the connectivity principles urged upon us by Professor Heyman and Dr. Gell-Mann.

Urban planning scholars reference the behavior of complex adaptive systems and the field of diffusion of innovations to define how regional planning networks can work to rationalize land use planning and control. According to David E. Booher and Judith E. Innes:

> Network power emerges from communication and collaboration among individuals, agencies, and businesses in a society. Network power emerges as diverse participants in a network focus on a common task and develop shared meanings and common heuristics for action. It grows as these players identify and build on their interdependencies to create new potential. In the process, innovations and novel responses to environmental stresses can emerge. These innovations, in turn, make possible adaptive change and constructive action of the whole.[33]

When my Yale students explored why communities adopted exemplary local environmental laws, they found out that most resulted from the work of community leaders reacting to damage to the local environment. They named these "perturbations" and called this the "perturbation effect."[34] Scholars who study diffusion theory observe how change happens in social systems and document the processes by which successful change occurs.[35] Their focus is also on connectivity.[36] They observe that outside change agents are most successful when they place new tools in the hands of respected local leaders.

When those leaders adopt an innovative solution, others pay attention. As a successful change occurs, the rest of the community catches on, a tipping point is reached, and the innovation becomes permanent. Successful change in these communities spread to nearby places confronting similar problems. In the study of urban planning, researchers describe how local and regional planning networks can be created to link local responses to address common, transboundary problems.

Local stakeholders represent the components of the municipal complex adaptive system. By being engaged in public processes, they can achieve consensus about how to respond to flooding, drought, mudslides, wildfires, sea-level rise, and storm surges—effects associated with climate change.[37] In response to these on-the-ground perturbations, they are motivated to learn how to mitigate the forces of climate change by reducing vehicle miles traveled (VMT), creating energy-efficient buildings, permitting and encouraging renewables and distributed energy generation facilities, and preserving natural systems that sequester carbon. As the local evidence of climate change becomes more and more evident, opinions often change as local leaders engage in solving the problems that threaten their environment and economy. They become committed to effective action and react aggressively to opportunities and threats.

III. Emerging Global Support for Local Solutions

Low-carbon land use is a logical subject to be included in the periodic assessment reports of the IPCC. The IPCC was formed by the World Meteorological Organization and the United Nations Environment Programme in 1988.[38] It began issuing climate change assessment reports in 1990 and warning, from the outset, that business as usual will result in unprecedented warming of the planet.[39] The first three assessment reports ignored the potential of shaping human settlements to mitigate climate change.[40]

31. Everett M. Rogers, Diffusion of Innovation 6 (5th ed. 2003).
32. *Id.* at 414-15. (According to Rogers, "[a] champion is a charismatic individual who throws his or her weight behind an innovation, thus overcoming indifference or resistance that the new idea may provoke in an organization." Rogers writes that according to studies of organizational change, the "important qualities of champions were that they (1) occupied a key linking position in their organization, (2) possessed analytical and intuitive skills in understanding various individuals' aspirations, and (3) demonstrated well-honed interpersonal and negotiating skills in working with other people in their organization.").
33. David E. Booher & Judith E. Innes, *Network Power in Collaborative Planning*, J. Plan. Educ. & Res. 221, 225 (2002) ("Like a complex adaptive system, [the planning network] as a whole is more capable of learning and adaptation in the face of fragmentation and rapid change than a set of disconnected agents.").
34. Students in the author's classes at the Yale School of Forestry and Environmental Studies conducted research on local environmental and smart growth laws adopted by municipalities in all 50 states, identifying well-crafted and exemplary laws and interviewing the local land use leaders involved in drafting and securing the adoption of these laws. *See* Yale School of Forestry & Environmental Studies, Report Number 2: Gaining Ground Information Database (John R. Nolon et al. eds., 2004) (describing the methodology and conclusions of this research).
35. *See, e.g.*, Booher & Innes, *supra* note 33.
36. *See* John R. Nolon, *Champions of Change: Reinventing Democracy Through Land Law Reform*, 30 Harv. Env't L. Rev. 1 (2006).
37. *See id.*
38. *History*, IPCC, https://www.ipcc.ch/about/history/ (last visited Aug. 14, 2020).
39. Climate Change: The IPCC 1990 and 1992 Assessments, IPCC (1992), https://archive.ipcc.ch/ipccreports/1992%20IPCC%20Supplement/IPCC_1990_and_1992_Assessments/English/ipcc_90_92_assessments_far_full_report.pdf.
40. *Id.*; IPCC Second Assessment: Climate Change 1995, IPCC (1995), https://archive.ipcc.ch/pdf/climate-changes-1995/ipcc-2nd-assessment/2nd-assessment-en.pdf; Climate Change 2001: Synthesis Report, IPCC (2001), http://www.grida.no/publications/267.

There was a tip of the hat to low-carbon land use in the IPCC's Fourth Assessment Report, issued in 2007.[41] While the report noted that climate change can be managed by controlling sprawl, promoting compact, mixed-use development, and modern land use planning, the IPCC was reluctant to go further and include a full chapter on the details because there was insufficient evidence in the literature documenting that strategy.

I attended an Expert Meeting on Human Settlement and Infrastructure organized by the IPCC in Calcutta in 2011. The correspondence that I received stated that "[o]ne motivation for this meeting is the significant percentage of global greenhouse gases attributable to human settlements and their infrastructure."[42] We knew then that land use patterns can be shaped by land use law to mitigate climate change. Our task was to demonstrate that there was ample research to support a chapter on human settlement in the next assessment report.

We prepared for this Expert Meeting by publishing a report on the literature that was published in 2011.[43] Our report demonstrated what many of the assembled experts knew: that the techniques mentioned in the Fourth Assessment Report, and many more like them, can be employed to reduce carbon emissions at the local level. The input of this group of experts was instrumental in convincing the IPCC to add a full chapter on the subject in its next report.[44]

Chapter Twelve of the IPCC's Fifth Assessment Report addresses the relationship between the shape of human settlements and climate change mitigation.[45] It focuses heavily on urban form, infrastructure, and land use mix. The chapter notes that mixed-use neighborhoods shape development so as to reduce the amount of CO_2 through the efficient use of energy and the reduction of vehicle trips and auto emissions.[46] This new chapter includes climate change mitigation strategies like use restrictions, density regulations, urban containment instruments, building codes, parking regulations, design regulations, and affordable housing mandates.[47] The chapter discusses land acquisition and management through the transfer of development rights and increasing green space and urban carbon sinks.[48]

As if to prove the IPPC right, local and state governments began to organize "sub-national" consortia to carry this message to Paris to influence the content of the agreement to be entered into by COP21. The "Under2 MOU," for example, was created in 2015 in order to influence policy at the convention.[49] It included a commitment by signatories (subnational governments) and endorsers (national governments) to reduce their GHG emissions 80-95% below 1990 levels by 2050.[50] It was signed by 222 jurisdictions representing countries on six continents, 1.3 billion people, and over 43% of the global economy.[51] Among the United States signatories were 12 cities, 11 states, and two counties.[52]

The Paris Agreement[53] on combating climate change and its effects was reached on December 12, 2015, at the UNFCCC COP21.[54] It endorsed the role of local governments in mitigating climate change and invited their participation in the international agreement by memorializing bottom-up strategies as NDCs.[55] This approach broadened international climate policy by including state and local government actors and inviting them to demonstrate how they can contribute to climate change mitigation.

The United States signed the agreement on Earth Day and ratified it by acceptance on September 3, 2016.[56] The United States submitted its NDC to the United Nations (U.N.) in March 2016, relying primarily on stricter emissions standards for coal-fired energy generation plants and similar top-down contributions.[57] China, the world's leading emitter, took a different approach; its NDC includes emission reductions that rely on the construction of green buildings, renewable energy in buildings, low-carbon community operations, low-carbon transportation systems, and promoting pedestrian- and bicycle-oriented neighborhoods.[58] By 2020, China says, 30% of travel will be by transit and 50% of new buildings will be green.

41. Climate Change 2007: Synthesis Report, IPCC (2007), https://archive.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr_full_report.pdf.
42. Letter from Ottmar Edenhofer et al., Co-Chairs of IPCC Working Group III, to John R. Nolon, Distinguished Professor of Law, Elisabeth Haub School of Law (Feb. 2, 2010) (on file with author).
43. Margaret E. Byerly, *A Report to the IPCC on Research Connecting Human Settlements, Infrastructure, and Climate Change*, 28 Pace Env't L. Rev. 936 (2011), https://digitalcommons.pace.edu/pelr/vol28/iss3/8.
44. Seto & Dhakal, *supra* note 1, at 923.
45. *Id.* at 930.
46. *Id.* at 956.
47. *Id.* at 962-63.
48. *Id.* at 963-64.
49. The governments that have ratified the United Nations Framework Convention on Climate Change (UNFCC) are known as Parties to the Convention and meet annually at a Conference of the parties, or the COP. Currently, there are 197 Parties to the Convention. *See Climate: Get the Big Picture*, UNFCCC, http://bigpicture.unfccc.int/#content-the-paris-agreement (last visited Aug. 14, 2020).
50. *Frequently Asked Questions*, UNDER2 (Aug. 14, 2020), http://www.under2coalition.org/frequently-asked-questions.
51. *Biggest Ever Gathering of Global States and Regions on Climate Action*, UNDER2 (Aug. 14, 2020), https://www.under2coalition.org/news/biggest-ever-gathering-global-states-and-regions-climate-action.
52. *States and Regions*, UNDER2 (Aug. 14, 2020), http://www.under2coalition.org/members.
53. Conference of the Parties' Twenty-First Session, U.N. Framework Convention on Climate Change, *Paris Agreement*, U.N. Doc. FCCC/CP/2015/L.9/Rev.1 (Dec. 12, 2015) [hereinafter *Paris Agreement*].
54. *What Is the Paris Agreement*, *supra* note 2. The Paris Agreement sought to limit the rise of global temperatures below 2 degrees Celsius and aid countries in adapting to the changes wrought by climate change. April 22, 2016, Earth Day, marked the day parties could sign the Agreement. *Climate: Get the Big Picture, supra* note 49. It entered into force on November 4, 2016, after the "double threshold," ratification by 55 countries representing 55% of emissions, was met. As of Aug. 14, 2020, 189 parties have ratified the agreement. *Paris Agreement—Status of Ratification*, UNFCCC, https://unfccc.int/process/the-paris-agreement/status-of-ratification (last visited Aug. 14, 2020).
55. *Paris Agreement—Status of Ratification, supra* note 54.
56. *Chapter XXVII: Environment*, United Nations Treaty Collection, https://treaties.un.org/Pages/ViewDetails.aspx?src=TREATY&mtdsg_no=XXVII-7-d&chapter=27&clang=_en (last visited Aug. 14, 2020).
57. *The Key Players in Climate Change*, N.Y. Times, Apr. 21, 2016, https://www.nytimes.com/interactive/2016/04/21/science/paris-agreement-carbon-dioxide-global-warming.html.
58. Embassy of the People's Republic of China in the Republic of the Philippines, Enhanced Actions on Climate Change: China's Intend-

The outpouring of support for state and local actions to manage climate change following adoption of the Paris Agreement demonstrates the subnational commitment to climate change mitigation. One thousand two hundred non-party stakeholders, for example, signed the "Paris Pledge for Action" to demonstrate their commitment to the agreement's goals.[59] It was not intended to copy the good work being done by local governments, but to demonstrate "the breadth of support and scale of momentum for a transition to a low-emission and climate resilient economy."[60]

This post-Paris contagion was not halted by President Donald Trump's announcement of his intention to withdraw from the Paris Agreement on June 1, 2017.[61] If anything, the subnational support has grown exponentially. The U.S. Climate Alliance (USCA) was created in direct response to the federal government's decision to withdraw from the Paris Agreement.[62] It is a bipartisan coalition of 24 states and one territory[63] that accounts for 55% of the U.S. population and $11.7 trillion of the U.S. economy.[64] These subnational actors are committed to reducing greenhouse gas (GHG) emissions in accordance with the U.S. target under the Paris Agreement[65] and building the USCA Clearinghouse, a website that will collect climate information and data for use by policymakers and the public.[66]

Initially released on June 5, 2017, the "We Are Still In" pledge to uphold the Paris Agreement comprises a coalition of more than 3,800 business, economic, government, and cultural leaders representing 155.0 million Americans and $9 trillion of the U.S. economy, spanning all 50 states.[67] "America's Pledge" is a separate initiative working in conjunction with "We Are Still In" to collect and organize the various climate actions of local actors across the United States.[68] Its September 2019 report quantifies the action of nonfederal actors in support of the Paris Agreement and found that 25 states, 430 cities, and over 3,800 climate action groups like businesses and communities, representing nearly 70% of U.S. gross domestic product, are still committed to implementing its goals.[69]

As of August 2020, 461 U.S. Climate Mayors representing 72 million Americans have committed to upholding the goals of the Paris Agreement.[70] Their statement was clear: "We will increase our efforts to cut greenhouse gas emissions, create a clean energy economy, and stand for environmental justice."

In initiating the U.S. withdrawal from the Paris Agreement, the president noted that he represented the citizens of Pittsburgh, not Paris.[71] Shortly thereafter, Pittsburgh city leaders pledged to implement their own climate action plans, and Pittsburgh Mayor Bill Peduto committed his city to the agreement by issuing an executive order in June 2017, pledging to continue efforts to cut energy consumption in half and develop a fossil fuel-free fleet of city vehicles.[72] The following year, Pittsburgh effectuated its pledge through a revitalized Climate Action Plan with clear goals for 2030, like establishing a fossil fuel-free fleet of vehicles and relying solely on renewable energy sources.[73]

On June 7, 2017, the mayor of Paris, Anne Hidalgo, and Mayor Peduto penned an op-ed responding to President Trump's comments.[74] The article explores the plight of Pittsburgh as its steel industry declined; the emergence of Pittsburgh as a revitalizing force; the reclaiming of Parisian roads from polluting vehicles for pedestrian use; and the involvement of both cities in the Global Covenant of Mayors for Climate and Energy and the "We Are Still In" Pledge. These mayors find themselves united by "a desire to do what is best for our citizens and our planet. That means putting aside parochial politics and embracing the global challenge of fighting climate change."

These mayors know what the IPCC learned: that the legal system we use to control development enables local governments to affect about 70% of the sources of CO_2

ED NATIONALLY DETERMINED CONTRIBUTIONS 9-10 (unofficial translation July 3, 2015) https://www.fmprc.gov.cn/ce/ceph/eng/xwdt/t1278239.htm.

59. *Letter From Minister Segolene Royal and Christiana Figures*, PARIS PLEDGE FOR ACTION (Apr. 21, 2016), http://www.parispledgeforaction.org/wp-content/uploads/2015/08/Paris-Pledge-for-Action-Communication.pdf.

60. *About*, PARIS PLEDGE FOR ACTION, http://parispledgeforaction.org/about/ (last visited Aug. 14, 2020).

61. Michael D. Shear, *Trump Will Withdraw U.S. From Paris Climate Agreement*, N.Y. TIMES, June 1, 2017, https://www.nytimes.com/2017/06/01/climate/trump-paris-climate-agreement.html. On Aug. 4, 2017, the U.S. State Department officially informed the United Nations of its withdrawal. Valerie Volcovici, *U.S. Submits Formal Notice of Withdrawal From Paris Climate Pact*, REUTERS, Aug. 4, 2017, https://www.reuters.com/article/us-un-climate-usa-paris/u-s-submits-formal-notice-of-withdrawal-from-paris-climate-pact-idUSKBN1AK2FM. In accordance with the withdrawal process, the earliest date for the United States to completely withdraw is Nov. 4, 2020, one day after the U.S. presidential election.

62. *About: Alliance Principles*, U.S. CLIMATE ALLIANCE, https://www.usclimatealliance.org/alliance-principles/ (last visited Aug. 14, 2020).

63. *About: Governors*, U.S. CLIMATE ALLIANCE, https://www.usclimatealliance.org/governors-1/ (last visited Aug. 14, 2020). (California, Colorado, Connecticut, Delaware, Hawaii, Illinois, Maine, Maryland, Massachusetts, Michigan, Minnesota, Montana, Nevada, New Jersey, New Mexico, New York, North Carolina, Oregon, Pennsylvania, Puerto Rico, Rhode Island, Vermont, Virginia, Washington, and Wisconsin).

64. *U.S. Climate Alliance 2019 Fact Sheet*, U.S. CLIMATE ALLIANCE, https://www.usclimatealliance.org/us-climate-alliance-fact-sheet (last visited Aug. 14, 2020).

65. *About: Alliance Principles*, *supra* note 62 (26-28% reduction in GHG emissions below 2005 levels by 2025).

66. U.S. CLIMATE ALLIANCE: U.S. CLIMATE ALLIANCE CLEARINGHOUSE, http://usclimatealliancecleringhouse.org (last visited Aug. 14, 2020).

67. *"We Are Still In" Declaration*, WE ARE STILL IN, https://www.wearestillin.com/about (last visited Aug. 14, 2020).

68. *About America's Pledge*, AMERICA'S PLEDGE, https://www.americaspledgeonclimate.com/about/ (last visited Oct. 10, 2019).

69. *The Reality of U.S. Climate Action: Non-Federal Leadership Is Delivering Ambition and Action*, AMERICA'S PLEDGE (Sept. 2019), https://www.bbhub.io/dotorg/sites/28/2019/09/The-Reality-of-U.S.-Climate-Action-Non-Federal-Leadership-is-Delivering-Ambition-and-Action.pdf.

70. *Paris Climate Agreement*, CLIMATE MAYORS, http://climatemayors.org/actions/paris-climate-agreement/ (last visited Aug. 14, 2020).

71. Kim Lyons et al., *A Revitalized Pittsburgh Says the President Used a Rusty Metaphor*, N.Y. TIMES, June 2, 2017, https://www.nytimes.com/2017/06/02/upshot/a-revitalized-pittsburgh-suggests-the-president-used-a-rusty-metaphor.html?_r=0.

72. *See* Erin Haines Whack & Dake Kang, *Pittsburgh to Trump: You Don't Speak for Us on Climate*, AP NEWS (June 2, 2017), https://www.apnews.com/162d760229dd4b42a87a6b2759b07588.

73. CLIMATE ACTION PLAN 3.0, CITY OF PITTSBURGH (2018), https://apps.pittsburghpa.gov/redtail/images/7101_Pittsburgh_Climate_Action_Plan_3.0.pdf.

74. Anne Hidalgo & William Peduto, *The Mayors of Pittsburgh and Paris: We Have Our Own Climate Deal*, N.Y. TIMES, June 7, 2017, https://www.nytimes.com/2017/06/07/opinion/the-mayors-of-pittsburgh-and-paris-we-have-our-own-climate-deal.html.

emissions or their means of capture.[75] This connection between land use law and carbon emissions is addressed in Part IV, immediately below.

IV. Mitigating Climate Change: The Land Use Connection

Local land use law can permit McMansions: super-large homes that consume outsized quantities of fossil fuel for heating and cooling. The law that allows the resulting emissions can be changed. Larger houses can be required to be more fuel-efficient and home sizes can be capped. In Marin County, California, for example, a land use regulation requires that the larger the house, the more energy-efficient it must be.[76]

Local law can also encourage or require passive construction resulting in ultra-low energy-consuming buildings that use little power for space heating or cooling. Passive homes are a relatively recent innovation that have evolved quickly. They include a 30-unit apartment building for senior citizens in Milton, Vermont, where the fuel bill for the entire complex is less than any one of the single-family homes that the seniors are selling so that they can move in.[77] What architects and engineers can do, the law can encourage or require. These modest examples focus on the critical fact that residential and commercial buildings contribute nearly 40% of national CO_2 emissions.[78]

Another approach to lowering energy consumption in houses is to make them smaller; smaller homes have less space to heat and cool, which reduces their contribution to fossil fuel emissions. Decades ago, in Petaluma, California, where zoning initially favored single-family construction, the city rebalanced the future housing stock by adopting the "Petaluma Plan" to accommodate sudden growth pressures in the 1970s.[79] The plan—and the zoning that implemented it—limited growth to 500 dwelling units per year.[80] Using an intricate point system, it rewarded builders who proposed projects that conformed to the plan and its environmental design standards. The land use regulations required that new housing produced be evenly divided between single-family and multi-family dwelling units, a consequence that caused less energy consumption and fewer emissions per capita.

The per capita result is critical. The population of the United States is growing, and that growth is significant. It matters where and how people live. In 2015, the average New York City dweller emitted 6.1 metric tons of CO_2 equivalent emissions annually.[81] Nationally, the per capita average emission metric is 19 tons.

Similarly, land use regulations can reduce VMT. The movement of personal vehicles through the built environment contributes more than 20% of CO_2 nationally.[82] Cars travel to convey their occupants from where they live to where they work, play, shop, and learn. The more distance between these destinations, the more miles travelled, and the more emissions generated. By creating mixed-use, higher density zones around transit stations, local governments can significantly lower CO_2 emissions. When density is increased for both residential and commercial uses, the distance between origin and destination is shorter, and walking, bicycling, and mass transit services are more feasible. Studies have shown that mixed-use zoning and increased population density decrease automobile ownership and the number of vehicle trips taken and VMT.[83]

Centering growth has a corollary benefit. It focuses needed development on urban places and moves it away from undeveloped open spaces. In those places, ecological services on which life and prosperity depend are preserved as a consequence. One of those services is the biological sequestration of CO_2.[84] Up to 18.2% of CO_2 emissions are sequestered by the natural environment.[85]

As sprawling development consumed increasing amounts of open lands during the last quarter of the 20th century and into the 21st, local land use law responded. Its toolbox is now full of sequestration-enhancing implements: clustering development; planned unit development ordinances; and neighborhood tree canopy enhancement standards, for example. Sustainable neighborhood design standards include green roofs, rain gardens, vegetated swales, xeriscaped lawns, biologically rich site design, and connected green landscapes. All of these land use laws protect and enhance the biologically sequestering environment and reduce the climate-changing emissions from all sources.

The connections between land use law and emissions are demand side strategies. They either reduce the demand for fossil fuels by lowering energy use in buildings and the emissions attributable to VMT, or they capture the resulting emissions through the natural environment. All told, these strategies address about 70% of the sources of CO_2 emissions or the means of capturing them.[86]

These strategies operate in a different policy sphere from more traditional GHG mitigation initiatives such as

75. *See supra* note 18. *See also infra* text accompanying notes 102, 127, and 138.
76. *See* County of Marin, Cal., Ordinance §19.04.140 (2019).
77. *See* Jeffrey Spivak, *Multiple Efficiencies for Multifamily*, Am. Plan. Ass'n Mag., Oct. 2017, http://eecoordinator.info/wp-content/uploads/2017/12/Planning-magazine-Passive-Housing.pdf.
78. *See* EPA Greenhouse Gas Inventory 2015, *supra* note 18. *See also infra* text accompanying note 102.
79. Construction Indus. Ass'n of Sonoma Cty. v. City of Petaluma, 522 F.2d 897, 900-01 (9th Cir. 1975).
80. *Id.* at 901.
81. Inventory of New York City's Greenhouse Gas Emissions, City of New York 8 (2017), https://www.dec.ny.gov/docs/administration_pdf/nycghg.pdf.
82. *See* EPA Greenhouse Gas Inventory 2015, *supra* note 18, at ES-11.
83. *See* U.S. Dep't of Transp., Transportation's Role in Reducing U.S. Greenhouse Gas Emissions—Volume 1: Synthesis Report to Congress ES-7 (2010), http://www.reconnectingamerica.org/assets/Uploads/DOTClimateChangeReport-April2010-Volume1and2.pdf [hereinafter Transportation's Role].
84. *See infra* Part V.C.
85. *See* John R. Nolon, *Land Use for Energy Conservation and Sustainable Development: A New Path Toward Climate Mitigation*, 27 J. Land Use & Env't L. 296, 312 (2012) [hereinafter *A New Path*].
86. *See supra* note 18. *See also infra* text accompanying notes 102, 127, and 138.

a carbon tax, cap-and-trade mechanisms, or clean power regulations affecting coal-fired generation. At the national level, these supply-centered strategies are mostly on hold for the duration of the current Administration.[87] The opposite is true of strategies employing land use tools on the demand-side.[88] As demonstrated above, the Paris Agreement embraced these strategies as valued NDCs to climate change mitigation.[89]

The concept that municipal governments can physically shape their own development is not well understood. The uniform, single-use settlement pattern was originally created by zoning designed communities to accomplish discrete objectives such as protecting child health and safety, controlling traffic congestion, and providing housing and commercial space to meet market demands.[90] As time progressed, the environmental and economic harm caused by the resultant urban patterns led many local governments to reshape their settlements.

The 1972 Petaluma Plan discussed above rebalanced the future housing stock of the city through zoning reform that required an even mix of single-family and multi-family housing.[91] The local legislature changed its land use law to achieve more environmentally friendly design, protect open space, create a greenbelt around the community, provide for a variety of housing choices, evenly distribute housing between the east and west sides of the city, and service growth efficiently.[92] Only in retrospect do we recognize these strategies as mitigation measures that reduce per capita energy consumption and protect the sequestering environment.

Petaluma's reforms were not novel, even in 1972. In 1937, for example, the local legislature in Bridgeport, Connecticut, amended its zoning ordinance to allow small commercial developments along major arterials in single-family neighborhoods in order to reduce downtown traffic congestion.[93] As the population increased in Bridgeport's single-family zones, more and more residents drove to the central business district to shop for goods and services. The commercial uses allowed in these new small districts included hardware, grocery, and drug stores, bake shops, and beauty parlors. Permitting these developments reduced downtown congestion, but also vehicle trips and VMT, one of the largest contributors to CO_2 emissions. This climate change mitigation effect was not on the minds of Bridgeport's legislators at the time, but the zoning technique they created can be used today to reduce carbon emissions from vehicle travel.

A decade after Bridgeport's innovation, the village of Tarrytown, New York, adopted a floating zone to provide affordable garden apartments to attract workers needed for employers whose businesses were essential to stabilizing the village's real property tax base.[94] The 1947 zoning ordinance created a floating garden apartment zone, but it did not specify where the dwelling units would be permitted. This was left to private-market developers who could petition the village legislature for a zoning map amendment, allowing them to build garden apartments. Significant landscaping was required to buffer the effect of multi-family housing in single-family neighborhoods where the new housing type was permitted.[95] By zoning for workforce housing close to jobs and requiring significant landscaping, the village created a mechanism that communities today can use to mitigate climate change.

In the 1980s, Omaha, Nebraska, reconfigured its urban form by adopting a planned unit development zoning ordinance.[96] This legislative reform permitted the developer to create a large, mixed-use neighborhood, while preserving much of the rezoned acreage as open space.[97] The city entered into a multi-phase agreement with the developer that specified the many details of the development—techniques designed to allow the developer to meet new market needs for mixed-use development and protect the downstream riparian owners from flooding.[98] Indirectly, climate change was mitigated, and community resilience promoted the creation of a walkable neighborhood and the preservation of sequestering open space.

As discussed above, there are many who doubt that parochial local governments can respond in any significant way to the challenge of global climate change. There are, however, many local land use tools available to them that clearly reduce or sequester carbon emissions. The local climate change mitigation toolbox has been stocking up for decades. Techniques created for a different purpose are now being used by localities for a highly challenging purpose. As the first responders to climate-caused disasters and damage, local leaders are highly motivated to act. The wisdom of the IPCC in including shaping human settlements as a critical mitigation strategy in its Fifth Assessment Report and Special Report on Climate Change and Land is increasingly evident as local governments quicken the pace of adopting such tools to respond to the perturbations of climate change.[99]

87. *See, e.g.*, Lisa Friedman & Brad Plumer, *EPA Announces Repeal of Major Obama-Era Carbon Emissions Rule*, N.Y. Times, Oct. 9, 2017, https://www.nytimes.com/2017/10/09/climate/clean-power-plan.html. *See also* John Schwartz, *Major Climate Change Rules the Trump Administration Is Reversing*, N.Y. Times, Aug. 29, 2019, https://www.nytimes.com/2019/08/29/climate-rule-trump-reversing.html.
88. *See infra* Part V.
89. *See supra* notes 52-58 and accompanying text.
90. *Zoning's Centennial*, *supra* note 9.
91. Construction Indus. Ass'n of Sonoma Cty. v. City of Petaluma, 522 F.2d 897, 901 (9th Cir. 1975).
92. *Id.* at 901-02.
93. Bartram v. Zoning Comm'n of City of Bridgeport, Conn., 68 A.2d 308, 310 (Conn. 1949).
94. Rodgers v. Village of Tarrytown, 96 N.E.2d 731, 732 (N.Y. 1951).
95. *Id.* at 732-33.
96. Giger v. City of Omaha, 232 Neb. 676, 679, 442 N.W.2d 182, 187 (1989).
97. *Id.*, 442 N.W.3d at 187-88.
98. *Id.* at 698-99, 442 N.W.3d at 198.
99. Seto & Dhakal, *supra* note 1, at 930; Climate Change and Land, *supra* note 3.

V. Implementation: The Land Use Stabilization Wedge

In 2004, Princeton Profs. Stephen Pacala and Robert Socolow provided a framework for mitigating climate change through "stabilization wedges," each capable of preventing at least one billion metric tons of carbon emissions annually using existing technology.[100] This part presents a variation—the land use stabilization wedge.[101] Whether, in the aggregate, the existing land use techniques described below will prevent one billion or more metric tons of emissions each year depends on how many, and to what extent, local governments embrace them. This, in turn, may depend on how well their role in climate change mitigation is understood and supported by state and federal governments.

A. *Buildings Contribute 35% of CO_2 Emissions in the United States*

The first component of the land use stabilization wedge is buildings. The most recent U.S. Environmental Protection Agency (EPA) Greenhouse Gas Inventory estimates that residential and commercial buildings emit 35% of domestic CO_2 emissions.[102] The increased demand for new residential and commercial space is related directly to the consumption of fossil fuel and CO_2 emissions.[103] As a result, the legal authority to regulate building location and construction so as to reduce these emissions can be a critical component of climate change mitigation policy.

According to the U.S. Census Bureau, the U.S. population will increase by over 90 million people during the next 40 years.[104] Using today's domestic household size, there will be around 35 million new households.[105] This increase in population will expand market demand for new residential and commercial buildings and the rehabilitation or replacement of millions of structures that will age-out during the next four decades.[106]

The land use standards that dictate energy efficiency in new and substantially rehabilitated buildings are created by state and local governments.[107] The size and shape of buildings and their interior spaces, their thermal efficiency, and whether they are served by efficient energy sources are dictated and influenced by zoning and other local land use regulations.

Regarding building construction, state legislatures adopt energy conservation codes for buildings, which in many states are then adopted, enforced, and enhanced by municipal governments.[108] Locally enforced energy codes ensure that all new and substantially rehabilitated buildings are constructed with energy conservation in mind. The International Codes Council (ICC) gradually strengthens these energy-conserving code requirements and reissues new recommended standards every several years.[109] Most states have adopted the ICC's International Energy Conservation Code (IECC) as a baseline to conserve energy in new and substantially rehabilitated buildings.[110]

State law in some states allows local governments to adopt enhancements to the state energy code that achieve even greater conservation. In New York, the state developed the NY Stretch Code—Energy 2020, suitable for adoption by local governments.[111] Once adopted by a local government, developers will be required to build residential structures to standards that are roughly 20% more efficient than the base energy code currently in effect. Commercial building will be roughly 7% more efficient.[112]

The novel idea of requiring large, energy-consumptive houses to be more energy-efficient was demonstrated above by its incorporation into local law in Marin County, California.[113] The county requires large homes less than 4,000 square feet to either exceed energy conservation code requirements by 15%, by 20% if equipped with a photovoltaic system, or simply be all electric.[114] If the home is more than 4,000 square feet (sq. ft.), the standard is higher. If the energy sources are mixed, the home must exceed the state

100. Stephan Pacala & Robert Socolow, *Stabilization Wedges: Solving the Climate Problem for the Next 50 Years With Current Technologies*, 305 Science 968, 970 (2004), http://science.sciencemag.org/content/305/5686/968.
101. *See* John R. Nolon, *The Land Use Stabilization Wedge Strategy: Shifting Ground to Mitigate Climate Change*, 34 Wm. & Mary Env't L. & Pol'y Rev. 1 (2009) [hereinafter *Land Use Wedge Strategy*].
102. *See* EPA Greenhouse Gas Inventory 2015, *supra* note 18 (Total U.S. CO_2 emissions are 5,411.4 million metric tons of CO_2 equivalents MT CO_2 Eq.). After distributing electricity-related CO_2 emissions, the commercial and residential sectors make up 1,913.3 MMT CO_2 Eq. or 35% of total U.S. emissions.).
103. *See supra* Part IV.
104. Sandra L. Colby & Jennifer M. Ortman, Projections of the Size and Composition of the U.S. Population: 2014 to 2060, at 1 (2015), https://census.gov/content/dam/Census/library/publications/2015/demo/p25-1143.pdf ("Between 2014 and 2060, the U.S. population is projected to increase from 319 million to 417 million, reaching 400 million in 2051.").
105. U.S. Census Bureau, Households and Families: 2010, at 1 (Apr. 2012), https://www.census.gov/prod/cen2010/briefs/c2010br-14.pdf ("Of the total population in 2010, 300.8 million lived in 116.7 million households for an average of 2.58 people per household." Ninety-eight million additional people divided by 2.58 = 37.9 million additional households.).
106. *See A Look at the U.S. Commercial Building Stock: Results From EIA's 2012 Commercial Buildings Energy Consumption*, U.S. Energy Info. Admin. (Mar. 4, 2015), https://www.eia.gov/consumption/commercial/reports/2012/buildstock/ ("the commercial building stock is still fairly old, with about half of all buildings constructed before 1980; the median age of buildings in 2012 was 32 years"); Josh Miller, *The Aging Housing Stock*, Eye on Housing (Jan. 20, 2014), http://eyeonhousing.org/2014/01/the-aging-housing-stock/ ("41% of the owner occupied housing stock in the U.S. was built prior to 1969").
107. *See supra* text accompanying notes 86-100.
108. *See, e.g.*, *NYStretch Code-Energy 2020*, N.Y. State Energy Res. & Dev. Auth., https://www.nyserda.ny.gov/All-Programs/Programs/Energy-Code-Training/NYStretch-Energy-Code-2020.
109. *See* Jessica A. Bacher & Jennie C. Nolon, *Zoning and Land Use Planning: Energy Codes, Green Building Initiatives, and Beyond*, 38 Real Est. L.J. 231, 234 (2009).
110. *See, e.g.*, 2018 International Energy Conservation Code, ICC (Aug. 31, 2017), https://codes.iccsafe.org/public/document/iecc2018.
111. *NYStretch Code-Energy 2020*, *supra* note 108.
112. *Energy Codes: Training, Support Services, and Stretch Codes*, N.Y. State Energy Res. & Dev. Auth., https://www.nyserda.ny.gov/All-Programs/Programs/Energy-Code-Training (last visited Aug. 20, 2020).
113. *See* County of Marin, Cal., Ordinance §19.04.140 (2019).
114. *Id.* §19.04.100(E).

code in efficiency by 35% and generate as much energy as it is expected to use. If a home above 4,000 sq. ft. is all electric, it must exceed the state code by 20%. Alternatively, homeowners can opt to be compliant with Passive House Institute US (PHIUS) Standards. PHIUS provides guides for homeowners and developers to significantly decrease energy consumption and costs.[115]

Similarly, the town of Greenburgh, New York, amended its local code to require that "all new one- or two-family dwelling or multiple single-family dwelling (townhouse) of three stories or less . . . [b]e built to achieve a HERS [Home Energy Rating System] Index of 70 or less on the Residential Services Network (RESNET) Home Energy Rating System (HERS) . . . ."[116]

Also in New York, the town of Blooming Grove offers homebuilders a density bonus under its zoning code to encourage them to adopt Energy Star.[117] Energy Star is a voluntary set of standards, one of many that local governments may reference in their zoning and energy code requirements.[118] It governs appliances, heating and cooling systems, the thermal envelope, electrical, ventilation, and equipment efficiency. The town awards a 10% increase in the number of homes that can be constructed under local zoning in exchange for making them all Energy Star-compliant.[119]

Local land use boards can require developers and their design consultants to follow an integrated design process, where they collaborate during the early stages of the project review process to achieve the greatest possible energy conservation and cost reduction. It is at this stage that decisions can be made about building orientation, form, shading, energy-efficient exterior lighting, window size and location, rooflines and extensions, reflective roofing, height-to-floor ratios, and building features that relate to passive ventilation and cooling.

Using similar powers and administrative techniques, localities can promote the construction of passive homes, both single- and multi-family. Instead of mechanized systems providing heating or cooling, passive buildings rely on the construction materials and techniques to use significantly less energy.[120] Buildings in the United States that implement the latest passive house standards will only use 10 to 25% of the energy of similar-size, conventionally constructed residential structures.[121] Techniques used include thick insulation, exterior air sealing, fluid-applied silicone air barriers over plywood sheathing, triple-paned windows, and high-efficiency heat-recovery ventilators.

In Milton, Vermont, a nonprofit developer created multi-family senior apartments using passive building techniques.[122] The heating bill for these 30 senior households is expected to be 80% less than the cost of energy required by similar-size buildings, and even less than what the owners of many single-family homes in the community pay for heat. This technique holds great promise as passive houses are continuing to draw support from around the country with certified Passive House construction doubling almost every year.[123]

B. *Transportation—Personal Vehicles Contribute 19% of CO_2 Emissions*

The second component of the land use stabilization wedge focuses on transportation, which is the largest source of CO_2 emissions from fossil fuel combustion in the United States.[124] In 2016, Americans drove more than 3.2 trillion miles,[125] 89.8% of which is attributable to light-duty motor vehicles, i.e., passenger vehicles and light-duty trucks such as minivans and sport utility vehicles.[126] Light-duty motor vehicles account for 59.4% of total transportation CO_2 emissions, which contributes 19.1% of national CO_2 emissions.[127]

The Fifth Assessment Report of the IPCC, Chapter Twelve, targets the shaping of human settlements as a key to climate change mitigation.[128] It focuses on "the patterns and spatial arrangement of land use, transportation systems, and urban design elements, including the physical urban extent, layout of streets and buildings, as well as the internal configuration of settlements."[129] Chapter Twelve also notes that "areas with a high mix of land uses encourage a mix of residential and retail activity and thus increase the area's vitality and the aesthetic interest of the neighbourhood."[130] Land use regulations can ensure attractive buildings, personal neighborhood scales, and amenable green infrastructure.

Like Chapter Twelve of the IPCC Fifth Assessment, a 2010 U.S. Department of Transportation report finds that GHG emissions can be decreased by using transportation strategies.[131] It calculates that these strategies, includ-

115. About PHIUS, Passive House Alliance, https://www.phius.org/about/mission-history (last visited Aug. 14, 2020).
116. *See* Town of Greenburgh, N.Y., Code §100-20 (2011).
117. *See* Blooming Grove, N.Y., Town Code §235-14.1(A)(3) (2011).
118. Bacher & Nolon, *supra* note 109, at 234.
119. Blooming Grove, N.Y., Town Code §235-14.1(A)(3).
120. Spivak, *supra* note 77, at 38.
121. *Id.* at 40.
122. *Id.* at 38.
123. *Id.* at 38-39.
124. *See* EPA Greenhouse Gas Inventory 2015, *supra* note 18, at ES-11, fig. ES-7 (After distributing electricity-related emissions, transportation CO_2 emissions account for 34.5% of U.S. CO_2 emissions from burning fossil fuels).
125. *See* U.S. Dep't Transp., Traffic Volume Trends 2, Fed. Highway Admin. (2016), https://www.fhwa.dot.gov/policyinformation/travel_monitoring/16dectvt/16dectvt.pdf.
126. Table VM-1 FHWA Highway Statistics (FHWA 1996 through 2016), Fed. Highway Admin. (May 2018), https://www.fhwa.dot.gov/policyinformation/statistics/2016/vm1.cfm.
127. *See* EPA Greenhouse Gas Inventory 2015, *supra* note 18, at ES-11 (After distributing electricity-related emissions, the transportation sector contributes 1,740.1 MMT CO_2 Eq. or 32% of total U.S. CO_2 emissions. The largest sources of transportation emissions are passenger cars (42.3%); medium- and heavy-duty trucks (23.6%); and light-duty trucks, which include sport utility vehicles, pickup trucks, and minivans (17.1%). This article focuses on light-duty motor vehicles, i.e., passenger cars and light-duty trucks, which account for 1,3033.62 MMT CO_2 Eq. or 59.4% of U.S. transportation emissions and 19.1% of total U.S. emissions.).
128. Seto & Dhakal, *supra* note 1, at 930.
129. *Id.* at 942.
130. *Id.* at 956.
131. Transportation's Role, *supra* note 83, at ES-7

ing land use law reform, could decrease GHG emissions from transportation by 6% to 21% by 2050.[132] Similarly, a Barack Obama Administration report in 2016 identified a "pathway" to reduce GHG emissions involving smart growth patterns of development such as walkable, livable, mixed-use development.[133]

These fine points are critical. Promoting compact, mixed-use development by itself may not reduce driving much, particularly if walking and biking options are not part of the neighborhood design. There is a current debate raging in the urban planning literature on this point,[134] with recent statistical analyses suggesting less correlation between compact, mixed-use development and driving than previously posited.[135] On-the-ground experience and common sense, however, make it clear that this type of development, enhanced by livable design, conveniently located shops and amenities, safe passage, and supportive infrastructure, lures many drivers from their cars and lowers trips and miles traveled significantly.[136] Little can be done to reduce emissions from personal travel without this type of neighborhood development. What can be done to reduce emissions in compact, mixed-use neighborhoods is to provide a variety of mobility options including projects that enhance walking and biking, provide for safe and attractive pedestrian experiences, and create a human-scale sense of place.

The successful development of transit stations and rail and bus lines is dependent upon land use densities and mixed-use development. There must be a large enough number of commuters in a transit station area to provide a base level of ridership. In addition, ridership must be sufficiently diverse to ensure that people are traveling to work, to shop, to seek entertainment, and to go home at various times during the day, thereby increasing the cost efficiency of the transit system.

Even where communities are not served by transit systems, local leaders can create compact, mixed-use neighborhoods that reduce car trips and miles traveled. Zoning controls can limit the size of housing units and combine retail, office, and residential land uses, putting services, shops, and jobs in closer proximity to homes. Communities not yet served by transit can designate one or more priority growth districts and create overlay zones for them that allow greater densities and more land uses than permitted in the underlying zoning districts. By clustering development strategically, these growing localities position themselves for future service by commuter rail or bus rapid transit, thereby becoming "transit ready."

Suburban areas that adopt higher density, mixed-use zoning will find it easier politically to adopt strong environmental protection ordinances applicable to the land outside high-density zones. Where state law permits, density bonuses may be provided in denser suburban zones and cash contributions made by developers in exchange. This money can be used to purchase development rights from landowners in sensitive environmental areas outside the higher density zone, areas that mitigate climate change through biological sequestration. This balance between development and conservation can be accomplished within transit-served urban areas as well—highlighting again zoning's ability to create sustainable settlement patterns and to mitigate climate change.

C. *Sequestration—Captures 18% of Domestic CO_2 Emissions*

The green edge of the land use stabilization wedge is the biological sequestration of CO_2. It occurs within the natural environment: resources such as forests, pastures, meadows, croplands, urban trees, and green infrastructure.[137] These landscapes naturally absorb and store approximately 18.2% of domestic CO_2 emissions.[138] Perpetuating and expanding the sequestering environment is fundamentally a land use issue, one that is well within the capacity of land use law to address.

The discussion above on transportation described how shaping human settlements to promote walkable, livable communities directly mitigates climate change by reducing VMT and energy consumed in buildings. Compact, mixed-use and sustainable neighborhood development promoted by land use regulations are, therefore, essential strategies for lowering emissions. Fortunately, they also promote biological sequestration. Such development attracts population growth to urban places by creating healthy neighborhoods for living, working, and recreating, which preserves existing open space in outlying areas. One estimate calculates that doubling urban density alone would accommodate the entire projected population increase by mid-century, thereby saving an area the size of Connecticut[139]—and all of its sequestering resources—from development.[140]

Strategies that create green infrastructure in developing and developed places, while adding marginally to sequestration, are necessary if urban communities are to

132. *Id.* at ES-6.

133. *See* The White House, United States Mid-Century Strategy for Deep Decarbonization 33, 56-57 (2016), https://obamawhitehouse.archives.gov/sites/default/files/docs/mid_century_strategy_report-final.pdf.

134. *News Release: Study Sparks Debate Over Relationship Between Compact Development and Driving*, Am. Plan. Ass'n (Feb. 27, 2017), https://www.planning.org/blog/blogpost/9120808/.

135. *See* Mark R. Stevens, *Does Compact Development Make People Drive Less?*, 83 J. Am. Plan. 7 (2017).

136. *See* Reid Ewing & Robert Cervero, *"Does Compact Development Make People Drive Less?" The Answer Is Yes*, 83 J. Am. Plan. 19, 23 (2017).

137. *See* EPA Greenhouse Gas Inventory 2015, *supra* note 18, at ES-8.

138. *See* EPA Greenhouse Gas Inventory 2012, *supra* note 18, at ES-20.

139. *Connecticut Population, Land Area, and Density by Location*, Conn. Dep't Econ. & Community Dev., http://www.ct.gov/ecd/cwp/view.asp?A=1106&Q=250664 (last visited Aug. 14, 2020) (The area of Connecticut is 4845.4 square miles.).

140. *Land Use Wedge Strategy*, *supra* note 101, at 14:

> At a density of 15, rather than 7.5 dwelling units per acre, 40 million new households will consume half as much land. At 7.5 units per acre, these households will occupy nearly 5.5 million acres for housing alone. Doubling the net density per acre reduces that figure to roughly 2.5 million acres, a savings of nearly three million acres, just under 5,000 square miles: an area about the size of the state of Connecticut.

attract additional residents and workers. They are essential adaptive techniques as well. In developed cities, for example, tree canopies can be increased; green infrastructure added; urban gardens promoted; and buildings oriented to cool living environments, lessen the heat island effect, make cities attractive places to live, and soften the effects of higher densities.

If urban places do not accommodate population growth, outlying lands become targets for residential and commercial development. In these places, land use law can be particularly effective in designating and protecting lands that sequester carbon.[141] As suburban subdivisions are developed, they can be better situated in the existing vegetated landscape through thoughtful land use regulations. Furthermore, local governments can shape suburban and ex-urban land development to reduce land coverage and impervious surfaces, limit flooding, retain and add vegetation, protect community character, and prevent ground and surface water pollution. Together, such strategies limit development densities and tend to push population growth back toward developed centers and corridors.

Municipal governments in suburban and ex-urban areas have a long history of concern for the loss of open space and ecosystem services to encroaching development.[142] Decades-old local open space preservation laws and programs yield a number of strategies that can now be employed as sequestration techniques. These include standards regarding environmentally sensitive area designation, erosion and sedimentation control, grading, filling, drainage, soil disturbance, removal of vegetation, floodplains control, natural resource management, watershed, groundwater, watercourse, and wetland protection, landscaping requirements, ridgeline, steep slope, scenic resources, shoreline regulation, stormwater management, timber harvesting regulations, tree protection and canopy expansion, and the transfer of development rights from lands to be preserved to developable areas.

Most local environmental laws and natural resource protections of this type are enacted because of perturbations at the community level: the loss of a cherished viewshed, the gradual decline of visible open space, surface water or groundwater contamination, increased flooding, or the disappearance of treasured wildlife, among others. These disturbing influences motivate local stakeholders and their elected officials to act to address their causes. As a result, local governments are becoming increasingly reliable partners in the global effort to manage climate change.

This comes at a critical time. Local legal strategies that preserve and enhance the sequestering environment now have a place on the global stage due to the advent of NDCs in the Paris Agreement.[143] NDCs include contributions to climate change mitigation adopted by local governments that can be counted toward participating countries' efforts to achieve international climate mitigation goals.[144] Enhancing biological sequestration using local land use authority is such a contribution.

D. *Distributed Energy—Lost in Transmission*

When President Trump announced his decision to withdraw the United States from the Paris Agreement, he quipped that he was elected to represent the residents of Pittsburgh, not Paris.[145] His clever alliteration was hugely ironic.[146] Pittsburgh has long been a leader in mitigating climate change, using its local land use power and democratic processes to reduce energy consumption and fossil fuel emissions. The city's zoning code, in fact, aggressively facilitates one of the most promising mitigation measures, that of promoting distributed, or on-site, power generation.[147]

The most recent EPA Greenhouse Gas Inventory estimates that residential and commercial buildings emit 35% of domestic CO_2 emissions.[148] Shockingly, two-thirds of the fuel used to generate electrical power in the United States is lost as escaped heat at the point of generation and in transmission.[149] Many of our electrical generation plants are located at sites far removed from where the power is needed: where people live and work and industry operates. Much of the energy lost to generate electricity for the conventional power grid can be saved by on-site or distributed energy generation.

Pittsburgh, apparently unbeknownst to President Trump, is a model smart city. In response to the Department of Transportation's Smart City challenge in 2015,[150] the city developed a plan to create innovative, interconnected infrastructure that responds efficiently and affordably to the transportation and energy needs of local residents.[151] The city called it SmartPGH: a plan to integrate multiple interconnected systems, including a network of micro-grids that generate electricity on-site, greatly reducing the energy lost in remote generation and transmission.

The U.S. Department of Energy's research and development program defines a micro-grid as "a group of interconnected loads and distributed energy resources within clearly defined electrical boundaries that act as a single controllable entity with respect to the grid. A micro-grid can connect and disconnect from the grid to enable it to operate in

141. *See* Bronson W. Griscom et al., *Natural Climate Solutions*, 114 PNAS 11645 (2017).
142. For more information documenting the statements in this paragraph, see John R. Nolon, *Managing Climate Change Through Biological Sequestration: Open Space Law Redux*, 31 Stan. Env't L.J. 195 (2012) [hereinafter *Open Space Law Redux*].
143. *See Paris Agreement*, *supra* note 70.
144. *See supra* Part III.
145. *See* Shear, *supra* note 61.
146. *See* Lyons, *supra* note 71.
147. *See A New Path*, *supra* note 85.
148. *See* EPA Greenhouse Gas Inventory 2015, *supra* note 18, at ES-10, fig. ES-7.
149. E-mail from Tom Bourgeois, Deputy Director, Pace Energy and Climate Center, to John R. Nolon, Distinguished Professor of Law, Elisabeth Haub School of Law (Sept. 24, 2012, 12:31 pm) (on file with author).
150. *Smart City Challenge*, U.S. Dep't of Transp., https://www.transportation.gov/smartcity (last updated June 29, 2017).
151. City of Pitt., Once More Into the Future Dear Friends, https://www.transportation.gov/sites/dot.gov/files/docs/Pittsburgh-SCC-Technical-Application.pdf (last visited Aug. 14, 2020).

both grid-connected or island-mode."[152] Micro-grids can capture the heat used to generate power by converting it to the energy needed to cool and heat connected buildings. This is called combined heat and power (CHP).[153]

Micro-grids usually operate at the scale of multiple buildings, a city block, or a larger neighborhood and are, therefore, ideally subject to local planning and regulation.[154] They can be prevented or furthered by land use standards. At the local level, on-site generation and CHP facilities cannot be developed if not permitted by local zoning. Pittsburgh used its delegated power to adopt zoning and land use regulations to enable micro-grids to develop.[155] The City Council amended its municipal code to add a Performance Point System that incentivizes sustainable development. It awards developers density bonuses for points that they accumulate by developing sustainably, including the development of distributed energy systems such as micro-grids.

For zoning to permit or promote a land use, it must define that use and specify where it may be located and how it is to be regulated or facilitated. In one of the first such definitions of its kind, the Pittsburgh Zoning Code says: "Distributed Energy Systems shall mean a range of smaller-scale technologies designed to provide electricity and thermal energy closer to consumers. These approaches include fossil and renewable energy technologies, micro-grids, on-site energy storage, and combined heat and power systems."[156]

Pittsburgh enacted into law what the United States Green Building Council encourages developers to do to qualify for certification under its Leadership in Energy and Environmental Design (LEED) for Neighborhood Development (LEED-ND) rating program.[157] The council notes that zoning can allow for district heating and cooling facilities, as well as solar and wind systems, to be installed in certain buildings or their sites; land use review protocols can be used to encourage owners to provide them, and density bonuses can be granted to provide a financial incentive for them.

As demonstrated here, many energy technologies and facilities cannot be built if they are not permitted at the local level by zoning. Localities, like Pittsburgh, have the ability to incentivize energy-conserving development through density bonuses and partnerships involving funds from local capital budgets. Innovations in energy technology can be furthered and assimilated by an informed public that understands the seriousness of current problems and the feasibility of new solutions. Since zoning must conform to a comprehensive land use plan developed with robust citizen participation, land use planning provides a valuable opportunity to engage and inform the public.

E. *Renewable Energy—Community Power*

Community power is an emerging tool for implementing renewable energy technology. It is also a metaphor for the power of local governments to further or frustrate that resource. Historically, land use regulations were more of a hindrance than a help to the adoption of renewable energy facilities. In some communities, the soft costs of renewable energy facilities, including the expense of securing local approval for wind and solar energy systems, remained high while the cost of the systems declined. In others, these facilities were simply zoned out. This is changing and the pace of change is rapid.

The Pittsburgh Zoning Code defines distributed energy systems to include "a range of smaller-scale technologies designed to provide electricity and thermal energy closer to consumers," including renewable energy facilities.[158] The source of power for micro-grids, which is incentivized by this zoning law, can be small-scale renewable energy systems, such as community solar systems and small- to mid-size individual or clustered wind turbines or on-site solar panels.

Communities, like Pittsburgh, using their land use power, are mitigating climate change by defining types of emerging sources of renewable power and permitting those sources in zoning districts, requiring property owners to accommodate these sources or creatively incentivizing them in a variety of ways. The facilities supported by local land use laws can be called community power systems. These systems are studied as part of land use planning, being called for in comprehensive plans, defined by zoning codes, and permitted in certain districts, either as-of-right, as accessory or secondary uses, or as special permitted uses. Larger, higher intensity systems can be permitted by zoning but are often subject to protective standards.

A few state legislatures have preempted local authority to regulate renewable energy systems, particularly large-scale projects that are subject to state agency regulation and licensing.[159] But most mid-size and smaller systems remain subject to local regulation under the plenary authority delegated to local government to control private development.[160] This is understandable; the risks and impacts of

152. U.S. Dep't of Energy, Summary Report: 2012 DOE Micro-Grid Workshop 1 (June 30, 2012) https://www.energy.gov/sites/prod/files/2012%20Microgrid%20Workshop%20Report%2009102012.pdf.

153. *See A New Path*, *supra* note 85, at 312.

154. *See* U.S. Dep't of Energy, *supra* note 152.

155. *See* City of Pitt., P.A., Zoning Code art. VI, ch. 915, §915.07.B, https://library.municode.com/pa/pittsburgh/codes/code_of_ordinances?nodeId=PIZOCO_TITNINEZOCO_ARTVIDEST_CH915ENPEST_915.07PEPOSY. (This is a link to the Performance Point System within the Environmental Performance Standards, which are part of the Pittsburgh Zoning Code. This point system incentivizes desired sustainable actions by rewarding developers with bonuses depending on how many points they accumulate by implementing the sustainable standards. Performance-based metrics are used to reward developers who do sustainable development, e.g., micro-grids.)

156. *See id.* §915.07.C(7).

157. *Open Space Law Redux*, *supra* note 142, at 226-30.

158. *See* City of Pitt., P.A., Zoning Code art. VI, ch. 915, §915.07.C(7).

159. *See, e.g.*, John R. Nolon & Jessica A. Bacher, *Wind Power: An Exploration of Regulations and Litigation*, N.Y. L.J., Feb. 20, 2008, https://digitalcommons.pace.edu/lawfaculty/667/; John R. Nolon, *Mitigating Climate Change by Zoning for Solar Energy Systems: Embracing Clean Energy Technology in Zoning's Centennial Year*, Zoning & Plan. L. Rep., Dec. 2015, at 5 n.17, https://digitalcommons.pace.edu/lawfaculty/997/ [hereinafter *Embracing Clean Energy Technology*].

160. *Embracing Clean Energy Technology*, *supra* note 159, at 4.

energy systems are experienced firsthand locally by the residents of these communities.

When, for example, wind power companies first approach a community with a proposal to develop towers over 200 feet high, with blades nearly as long as a football field, neighbors naturally oppose them until their risks are understood and mitigated by regulation.[161] Less dramatically, a proposal to cluster a few smaller towers to serve on-site needs or even a single wind turbine on a residential roof will meet opposition initially. Residents, particularly adjacent neighbors, are concerned about the noise, visual interruption, ice throws, the strobe effect, change of neighborhood character, and the consequent diminution of their property values.[162] Since land use laws are based on intense democratic participation by the public, these risks have to be examined and, where they are well-founded, reduced or eliminated.

Local governments typically begin the process of regulating wind power by doing studies of wind generation systems, exploring both the risks and benefits, and memorializing their findings in a comprehensive land use plan amendment or adopting a land use policy.[163] They then define various types and sizes of wind energy systems and prohibit them in inappropriate locations and permit them in others, with needed safeguards. These laws create spacing and set-back requirements, limit or buffer noises, require aesthetic controls, and impose regulations on noise levels, viewshed interruptions, heights, location, size, lighting, color, or design. Some laws require local licenses and even provide for decommissioning.

Zoning for solar energy facilities proceeds in the same way. When the Land Use Law Center was retained to help draft a model solar energy law for communities in New York, we started by working with industry representatives to understand the various types, shapes, intensities, and other characteristics of these facilities. We realized that building integrated solar systems are part of the structure itself and should be exempted from land use regulation. Small-scale roof-top and ground-mounted systems should be permitted as-of-right or as accessory uses, and larger-scale systems were subject to special permits and site plan regulations.[164]

New York encourages local governments to expedite small-scale solar systems through its Unified Solar Permit (USP).[165] It applies to solar systems with a capacity of 12 kilowatts or less that are not subject to architectural or historical review board approval, do not require a zoning variance or a special use permit, and that are roof-mounted, compliant with building and related codes, and meet mounting and weight distribution requirements.

Without assured access to the rays of the sun, property owners may be discouraged from installing solar panels because the cost of the systems may not be recouped over time if sunlight is diminished by development on adjacent parcels. In most states, solar easements or nuisance actions for blocking the sun's energy are not recognized by common law.[166] Nevertheless, they can be created by local government regulation. Typically, these regulations require written and recorded solar easements that define easement dimensions, how the easement will terminate, and compensation for easement maintenance or interference, among other provisions.[167] This is an especially viable technique when applied through subdivision regulations to new developments.

Some localities are requiring developers to install solar energy systems or, short of that, to make buildings solar-ready.[168] Other communities incentivize, rather than require, these solar facilities, typically by providing density bonuses for solar panels, solar readiness, and solar access easements.[169]

VI. Resilience and Other Corollary Benefits of Localism

One of the first transit-oriented development projects that we worked on, after creating the Land Use Law Center, was the Hudson Park development in the city of Yonkers, New York. This was in the late 1990s when our focus was on sustainable development. That project eventually became a model of climate change mitigation featuring energy efficiency and reduced use of automobiles, greatly lowering per-household fossil fuel consumption and CO_2 emissions of building residents.[170]

As a sustainable development, however, Hudson Park did much more than mitigate climate change. It was built at a density of 130 units per acre, adjacent to an express stop on the commuter railroad. Compared to sprawling subdivision developments, Hudson Park reduced average per-household impervious coverage by 96%, lowered per capita water use by 60%, and avoided disrupting wetland and watercourse environments needed for adaptation to climate change and sequestration.[171] At 90% lot coverage, Hudson Park paved 36,000 sq. ft. per acre. At 130 dwelling units per acre, that amounts to 275 sq. ft. coverage per household.

The average suburban single-family home on a half-acre, in contrast, creates 8,000 sq. ft. of impervious coverage per household. On a per-household basis, Hudson Park greatly reduced flooding and stormwater damage, reduced non-point source pollution of surface water, conserved potable water, and preserved natural resources and their ecological

161. For more information documenting the statements in this paragraph, see Nolon & Bacher, *supra* note 159.
162. *See, e.g.*, Burch v. Nedpower Mount Storm, Ltd. Liab. Co., 220 W. Va. 443, 449 (W. Va. 2007).
163. *See* Nolon & Bacher, *supra* note 159.
164. *See Open Space Law Redux*, *supra* note 142 (for solar power regulation).
165. *See Unified Solar Permit*, N.Y. State Energy Res. & Dev. Authority, https://www.nyserda.ny.gov/All-Programs/Programs/Clean-Energy-Communities/Clean-Energy-Communities-Program-High-Impact-Action-Toolkits/Unified-Solar-Permit (last visited Aug. 14, 2020).
166. *Embracing Clean Energy Technology*, *supra* note 159, at 24.
167. *Id.* at 25.
168. *Id.* at 27-28.
169. *Id.* at 29.
170. More information on Hudson Park is available in a case study prepared for the Urban Land Institute, Westchester/Fairfield Chapter in 2018. The report is on file with the author.
171. All calculations in this paragraph are the author's.

functions.[172] Its effect was to make development resilient, adapting to climate change, as much as it was to mitigate climate change.

The corollary benefits of compact, mixed-use developments like Hudson Park are many and impressive. In addition to mitigating climate change, they also enable local governments to adapt to climate change. For instance, they avoid the use of prime agricultural soils, wetlands and species habitat: natural resources that create resilient open spaces.[173] Such developments reduce surface water pollution, because they create much less impervious coverage per household for buildings, paving, roads, and parking structures.[174] By leaving natural landscapes in place, they also allow nature to retain the capacity to filter precipitation, absorb and retain stormwater, and reduce the speed and devastation of flooding.[175]

Sustainable development projects, by reducing VMT per capita, also protect water quality by lowering tailpipe emissions and the hard metals and other toxic substances that drop off the undercarriage of vehicles onto impervious surfaces, such as driveways and parking lots, where they are washed into nearby rivers, streams, and other surface waters.[176]

To match the increasing focus of climate change adaptation to protect public health, sustainable development projects and sustainable neighborhoods can incorporate various strategies. For example, plans can maximize green infrastructure, promote walking and bicycling, provide active recreation areas, zone in public health services, and provide incentives to merchants to provide healthy foods.[177]

VII. Conclusion

Working at the local level on developments that mitigate climate change leverages additional environmental benefits, including many that are effective strategies for creating resilient developments and neighborhoods. These local initiatives help their communities adapt to climate change. In sum, they enable local governments to adopt and implement development plans that draw from the full spectrum of climate change management.[178]

Basing climate change management strategies on a sound local footing takes advantage of local government's significant legal authority and the powerful and demonstrated commitment of local citizens to solve on-the-ground environmental problems. A key lesson learned from observing change taking place locally is that state and federal governments must recalibrate their policies and programs to take full advantage of the partnership that grassroots governments offer. Most transformative change in our country has started locally and then built into significant national movements.[179] So it should be with the growing imperative to manage climate change effectively.

172. *Supra* note 170 and accompanying text.

173. *Open Space Law Redux*, *supra* note 142, at 327. Following the trend of making green buildings more sustainable, the U.S. Green Building Council's LEED system for rating and certifying projects, initially focused on building resource efficiency, has been supplemented with the LEED-ND system, which considers ranking factors such as the location of a project in a region to avoid building on wetlands, watercourses, and on prime agricultural land.

174. *See* Melissa G. Kramer, U.S. EPA, Our Built and Natural Environments: A Technical Review of the Interactions Among Land Use, Transportation, and Environmental Quality 94 (2d ed. 2013), https://www.epa.gov/sites/production/files/2014-03/documents/our-built-and-natural-environments.pdf.

175. *See* Christina M. Lyerly et al., New Insights: Science-Based Evidence of Water Quality Improvements, Challenges, and Opportunities in the Chesapeake 35 (2014), http://ian.umces.edu/pdfs/ian_report_438.pdf.

176. U.S. EPA, Protecting Water Resources With Smart Growth 30-31 (2004), https://www.epa.gov/sites/production/files/2014-04/documents/protecting-water-resources.pdf.

177. *See* Jennie Nolon Blanchard, *Legal Lessons: Zoning to Fight Obesity*, Am. Plan. Ass'n Mag., April 2018, https://www.planning.org/planning/2018/apr/legallessons/.

178. *See* Fatima Denton et al., *Climate-Resilient Pathways: Adaptation, Mitigation, and Sustainable Development*, *in* Climate Change 2014: Impacts, Adaptation, and Vulnerability 1117 (C.B. Field et al. eds. 2014) ("Because both adaptation and mitigation are parts of climate-resilient pathways, and because each benefits from progress with the other . . . integrating the two kinds of climate change responses within the broader context of sustainable development has been suggested as an aspirational goal.").

179. *See* James Fallows, *The Reinvention of America*, Atlantic, May 2018:

> The more we traveled, the more parallels and resonances we saw. . . . Every place had its local features, but together these efforts formed a pattern whose sweep and power can be hard to discern from any single instance. . . . And the evidence of past waves of reform, from the labor-rights and women's suffrage movements of the early 1900s through the civil-rights and environmental movements of mid-century, suggests that national transformations must start from local roots.

https://www.theatlantic.com/magazine/archive/2018/05/reinventing-america/556856/.