2019

Heat Waves: Legal Adaptation to the Most Lethal Climate Disaster (So Far)

Michael B. Gerrard
Columbia Law School, michael.gerrard@law.columbia.edu

HEAT WAVES: LEGAL ADAPTATION TO THE MOST LETHAL CLIMATE DISASTER (SO FAR)

Michael B. Gerrard[*]

I. INTRODUCTION

Globally, the ten warmest years on record have all been since 1998, with the four warmest years occurring since 2014.[1] In the contiguous United States, average annual temperatures are about 1.8°F higher than they were over the period from 1895–2016.[2] This is expected to increase by about 2.5°F before mid-century, regardless of what happens to greenhouse gas levels.[3] If, at the end of this century, greenhouse gas emissions are at the Intergovernmental Panel on Climate Change's high scenario (termed "RCP 8.5"), average U.S. temperatures could go up by as much as 11.9°F by 2100, with emissions at a middle scenario (RCP 4.5), and temperatures perhaps as little as 2.8°F.[4] This shows that greenhouse gas levels will not make much of a difference to what we experience over the next few decades, but will make a huge difference toward the end of the century. Even if the world meets the goal set at the Paris Climate Conference in 2015 of keeping rises well under 2°C (3.6°F) above pre-industrial levels, which seems increasingly unlikely, the average summer high temperature in the United States is expected to rise from a historical average of 74°F to an average of 81°F by 2100; with high emissions, that could be 91°F.[5]

---

* Michael B. Gerrard is Andrew Sabin Professor of Professional Practice and Faculty Director of the Sabin Center for Climate Change Law at Columbia Law School. He formerly chaired the faculty of Columbia University's Earth Institute, and the Section of Environment, Energy and Resources of the American Bar Association. Sheila Cornell, Elise Gout, Ashley Marie Gregor, and Daniel Leipow provided invaluable research assistance.

1. *State of the Climate in 2017*, 99 BULL. AM. METEOROLOGICAL SOC'Y, at S12 (Aug. 2018).

2. U.S. GLOB. CHANGE RES. PROGRAM, TEMPERATURE CHANGES IN THE UNITED STATES, IN CLIMATE SCIENCE SPECIAL REPORT: FOURTH NATIONAL CLIMATE ASSESSMENT, VOLUME I, 12, 186 (D.J. Wuebbles et al. eds., 2017), https://science2017.globalchange.gov/downloads/CSSR2017_FullReport.pdf [hereinafter CLIMATE SCIENCE SPECIAL REPORT].

3. *Id.* This is relative to 1976–2005.

4. *Id.*

5. Phil McKenna, *Southwest's Deadly Heat Wave Previews Life in a Warming World*, INSIDECLIMATE NEWS (June 23, 2017), https://insideclimatenews.org/news/23062017/deadly-heat-wave-southwest-climate-change; *see also,* Andrew D. King et al., *Reduced Heat Exposure by Limiting Global Warming to 1.5°C*, 8 NATURE CLIMATE CHANGE 549, 549–50 (2018).

All the above numbers are just about averages, but it is the extremes in time and place that have the greatest impacts. Extreme temperatures in the United States are projected to increase even more than average temperatures.[6] For every 1°C (1.8°F) that the temperature goes up, there may be around twenty-one more heatwave days in the western United States and twenty-six in the eastern states.[7] At high emissions levels, heatwaves that now occur once every twenty years could become annual events,[8] and the average number of extremely hot days could more than triple by the end of the century.[9]

The worst heatwave in modern history occurred in Russia in 2010; its rare combination of extreme temperatures and long duration killed an estimated 55,000 people.[10] Under an RCP 8.5 scenario, comparable heat waves could occur every two years in the eastern United States by the end of the century,[11] and by then in Europe, the legendary heat wave of 2003 "would be classed as an anomalously cold summer relative to the new climate."[12] These increased temperatures and heat waves are not just occurring randomly.[13] The science is clear that human activities—mostly greenhouse gas emissions and deforestation—are the major cause.[14]

---

6. CLIMATE SCIENCE SPECIAL REPORT, *supra* note 2, at 197.

7. S. E. Perkins-Kirkpatrick & P. B. Gibson, *Changes in Regional Heatwave Characteristics as a Function of Increasing Global Temperature*, 7 SCI. REPORTS, no. 12256, at 5 (2017).

8. CLIMATE SCIENCE SPECIAL REPORT, *supra* note 2, at 197.

9. U.S. ENVTL. PROT. AGENCY, OFFICE OF ATMOSPHERIC PROGRAMS, CLIMATE CHANGE IN THE UNITED STATES: BENEFITS OF GLOBAL ACTION 26 (2015) [hereinafter CLIMATE CHANGE].

10. Hannah Hoag, *Russian Summer Tops "Universal" Heatwave Index*, NATURE NEWS (Oct. 29, 2014), https://www.nature.com/news/russian-summer-tops-universal-heatwave-index-1.16250.

11. SIMONE RUSSO ET AL., HUMID HEAT WAVES AT DIFFERENT WARMING LEVELS, 7 SCI. REP. 3 (2017).

12. Peter A. Stott et al., *Human Contribution to the European Heatwave of 2003*, 432 NATURE 610, 613 (2004).

13. Øystein Hov et al., *Extreme Weather Events in Europe: Preparing for Climate Change Adaptation*, NORWEGIAN METEOROLOGICAL INST. (2013).

14. Noah S. Diffenbaugh, et al., *Quantifying the Influence of Global Warming on Unprecedented Extreme Climate Events*, 114 PNAS 4881, 4881–86 (2017); Benjamin O. Santer et al., *Human Influence on the Seasonal Cycle of Tropospheric Temperature*, SCIENCE, July 20, 2018, at 1; Quentin Lejeune et al., *Historical Deforestation Locally Increased the Intensity of Hot Days in Northern Midlatitudes*, NATURE CLIMATE CHANGE, May 2018, at 386 (2018); Quirin Schiermeier, *Droughts, Heatwaves and Floods: How to Tell When Climate Change is to Blame*, NATURE NEWS (July 30, 2018), https://www.nature.com/articles/d41586-018-05849-9; INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, MANAGING THE RISKS OF EXTREME EVENTS AND DISASTERS TO ADVANCE CLIMATE CHANGE ADAPTATION, (Christopher B. Field et al., eds. 2012), https://www.ipcc.ch/pdf/specialreports/srex/SREX_Full_Report.pdf.

This article discusses the impacts of rising heat; the methods available to cope with heat (principally air conditioning and the reduction of the urban heat island effect through cool roofs and enhanced vegetation); the existing regulations that deal with heat; and legal tools that can be adopted to enhance resilience to heat.

II. IMPACTS

A. Physical Health

These forecasts are bad news for human health. More people in the United States now die from heat than from any other weather-related event, and the heat-related death numbers are probably understated because "heat" usually is not the stated cause on death certificates.[15] A hotter world will mean more lethal heatwaves, and more people who are already in bad shape dying earlier. When it is hotter, more people show up in hospitals with heart disease, acute myocardial infarction, congestive heart failure,[16] and kidney stones.[17] More people get tick-borne diseases.[18] Babies born to mothers who lived in very hot conditions during pregnancy, and then were in hot places during the first year of life and without air conditioning, do not do as well later in life.[19] One model calculated that under a high emissions scenario, U.S. heat-related deaths in the period 2031–2050 would be 57% higher than those in 1971–2020, all else being equal.[20]

---

15. *Summary of Natural Hazard Statistics for 2016 the United States*, NAT'L WEATHER SERV. (2017), http://www.nws.noaa.gov/os/hazstats/sum16.pdf; Aimee Cunningham, *Are We Ready for the Deadly Heat Waves of the Future?*, SCI. NEWS (Apr. 3, 2018), https://www.sciencenews.org/article/are-we-ready-deadly-heat-waves-future; *Climate Change Indicators: Heat- Related Deaths*, U.S. ENVTL. PROTECTION AGENCY, https://www.epa.gov/climateindicators/climate-change-indicatorsheat-related-deaths (last updated Oct. 11, 2017).

16. Shakoor Hajat et al., *Health Effects of Hot Weather: From Awareness of Risk Factors to Effective Health Protection*, 375 LANCET 856, 858 (2010); Holly Ching Yu Lam et al., *Short-Term Association Between Ambient Temperature and Acute Myocardial Infarction Hospitalizations for Diabetes Mellitus Patients: A Time Series Study*, PLOS MED. (July 17, 2018), https://journals.plos.org/plosmedicine/article?id=10.1371/journal.pmed.1002612.

17. Michelle E. Ross et al., *Assessment of the Combination of Temperature and Relative Humidity on Kidney Stone Presentations*, 162 ENVTL. RES. 97, 98 (2018).

18. *Illnesses from Mosquito, Tick and Flea Bites Increasing in the US*, CTR. FOR DISEASE CONTROL & PREVENTION, https://www.cdc.gov/media/releases/2018/p0501-vs-vector-borne.html (last updated May 1, 2018); Felipe J. Colón-González et al., *Limiting Global-Mean Temperature Increase to 1.5–2 °C Could Reduce the Incidence and Spatial Spread of Dengue Fever in Latin America*, 115 PNAS 6243 (2018).

19. Adam Isen et al., *Relationship Between Season of Birth, Temperature Exposure, and Later Life Wellbeing*, 114 PNAS 13447, 13449 (2017).

20. Yuming Guo et al., *Quantifying Excess Deaths Related to Heatwaves Under Climate Change Scenarios: A Multicountry Time Series Modelling Study*, PLOS MED., app. S1 at

There is a limit to how much hot weather anyone can survive. If both the heat and the humidity are high enough and reach a combined measure called a "wet bulb temperature" of 35°C, a person's core body temperature rises, sweating becomes impossible, and death ensues.[21] This condition, termed "TW 35°C," can be endured for only about six hours, and then only if the person is in the shade, not working, and wearing no clothes.[22] TW 35°C does not seem to have occurred anywhere, but some places have gotten very close,[23] and by the late 21st Century (maybe earlier), under business as usual conditions (i.e., a continuation of current emission trends), it or other heat danger thresholds may be exceeded in portions of South Asia, the Persian Gulf, eastern and northern China, West Africa, and, under one set of assumptions, the eastern United States.[24] Without air conditioning or some other way of staying cool, these places could become lethal. Even well below TW 35°C, many people die of excess heat. Tens of thousands of deaths have occurred in heat waves at TW 29–31°C.[25] Under one estimate, by 2100, almost three-quarters of the world's population could be exposed to climatic conditions that cause excess mortality under the high emissions scenario, as opposed to one-half with the low emissions scenario and around one-third today.[26]

B. Mental Health

The impacts can extend to people's mental states. A 2018 study found that suicide rates rise 0.7% in the United States, and 2.1% in Mexico, for

---

Table D (July 31, 2018) https://journals.plos.org/plosmedicine/article?id=10.1371/journal.pmed.1002629.

21. Steven C. Sherwood et al., *An Adaptability Limit to Climate Change Due to Heat Stress*, 107 PNAS 9552, 9552 (2010).

22. *Id* at 9554.

23. Jason Samenow, *Iran City Hits Suffocating Heat Index of 165 Degrees, Near World Record*, WASH. POST (July 31, 2015), https://www.washingtonpost.com/news/capital-weather-gang/wp/2015/07/30/iran-city-hits-suffocating-heat-index-of-154-degrees-near-world-record/?utm_term=.20d8042a8721.

24. Eun-Soon Im et al., *Deadly Heat Waves Projected in the Densely Populated Agricultural Regions of South Asia*, SCI. ADVANCES, Aug. 2, 2017, at 1; Ethan D. Coffel et al., *Temperature and Humidity Based Projections of a Rapid Rise in Global Heat Stress Exposure During the 21st Century*, 13 ENVTL. RES. LETTERS 014001, at 5 (2018); Christoph Schär, *Climate Extremes: The Worst Heat Waves to Come*, 6 NATURE CLIMATE CHANGE 128, 128–29 (2016); Suchul Kang & Elfatih A.B. Eltahir, *North China Plain Threatened by Deadly Heatwaves Due to Climate Change and Irrigation*, 9 NATURE COMM. 2894, at 1 (2018).

25. Coffel, *supra* note 24, at 2–5; Salman Masood & Mike Ives, *As Asian Scorchers Multiply, Records Fall and Attention Rises*, N.Y. TIMES (June 17, 2017), https://www.nytimes.com/2017/06/17/world/asia/climate-change-asia-heat-records.html.

26. Camilo Mora et al., *Global Risk of Deadly Heat*, 7 NATURE CLIMATE CHANGE 501, 501 (2017). The low emissions scenario is RCP 2.6.

each 1°C increase in monthly average temperatures, and "depressive language" in social media posts rises with the thermometer.[27] Thus, by the end of the century, hot weather could lead to "a change in suicide rates comparable to the estimated impact of economic recessions, suicide prevention programmes or gun restriction laws."[28] Moreover, students do not learn as much when it is hot.[29] There are multiple theories for why, but one reason seems to be that neither students nor teachers are as productive in hot classrooms.[30]

C. Impact on Workers and Economy

People are less productive when it is hot. Montesquieu wrote in 1748 that an "excess of heat" made us "slothful and dispirited."[31] The link between temperature and labor productivity was documented as long ago as 1915.[32] Heat makes people work at a slower pace, increases accident risk, and lowers their cognitive ability.[33] For office work, optimum productivity is around 72°F; above 77°F it declines about 2% for every 1.8°F increase.[34] Outdoor labor in agriculture, construction, utilities and manufacturing (which together account for almost one-quarter of the U.S. work force) is especially susceptible, both because of the physical exertion and the lack of air conditioning.[35] One study found that at temperatures over 85°F, workers in industries with high exposure to climate are able to work about one hour less per day, compared to temperatures in the 76–80°F range.[36] This hits the paychecks of workers who are paid for their output (e.g. bushels of apples) or by the hour (if they can only work fewer hours) rather than receiving a set salary.

---

27. Marshall Burke et al., *Higher Temperatures Increase Suicide Rates in the United States and Mexico*, 8 NATURE CLIMATE CHANGE 723, 723 (2018).

28. *Id.*

29. Joshua Goodman et al., *Heat and Learning* 1 (Nat'l Bureau of Econ. Res., Working Paper No. 24639, 2018).

30. *Id.*

31. BARON DE MONTESQUIEU, THE SPIRIT OF LAWS 240 (Thomas Nugent trans., Colonial Press 1899) (1748).

32. Ellsworth Huntington, *Civilization and Climate* (1915), *cited in* Melissa Dell, et al., *What Do We Learn from the Weather? The New Climate-Economy Literature*, 52 J. ECON. LIT. 740, 759 (2014).

33. Tord Kjellstrom et al., *The Direct Impact of Climate Change on Regional Labor Productivity*, 64 ARCHIVES ENVTL. & OCCUPATIONAL HEALTH, no. 4, at 217 (2009).

34. O. Seppänen et al., *Room Temperature and Productivity in Office Work* (Lawrence Berkeley Nat'l Laboratory, Working Paper No. LBNL-60952, 2006).

35. TREVOR HOUSER et al., ECONOMIC RISKS OF CLIMATE CHANGE: AN AMERICAN PROSPECTUS*,* 68 (2015).

36. Joshua Graff Zivin & Matthew J. Neidell, *Temperature and the Allocation of Time: Implications for Climate Change*, 32 J. LAB. ECON. 1, 2 (2014).

This labor effect will harm the economy as a whole. With business as usual emissions, by the 2080s, about 9% of work days in North America could be lost due to heat,[37] and possibly much more during the hottest months.[38] The U.S. Environmental Protection Agency (EPA) estimates that by 2100, over 1.8 billion labor hours across the U.S. workforce will be lost due to unsuitable working conditions, mainly heat; this will total over $170 billion in lost wages that year.[39] A study for the Federal Reserve Bank of Richmond found that rising temperatures could reduce U.S. economic growth by up to one-third over the next century.[40] Another study estimated that for each degree Fahrenheit increase in global temperatures, the U.S. economy loses 0.7% of gross domestic product, with each degree of warming costing more than the last. "If global emissions growth is not slowed, then the resulting 6–10°F of warming projected for the last two decades of this century will have costs on par with the Great Recession—except they will be permanent, and damages for poor regions of the United States will be many times larger."[41] Unmitigated warming could reduce average global incomes roughly 23% by 2100, with hot, poor countries suffering the most.[42] A United Nations ("UN") report found that "more than one billion workers already grapple with dozens of additional extremely hot days each year in a year due to climate change alone."[43]

In the United States, manual laborers in general are all hit hard by heatwaves,[44] and farmworkers are among the most vulnerable. Their work is physically strenuous and entirely outdoors, with no shade; they have little flexibility in their days and hours of work.[45] Many of them "wear pants and long-sleeved shirts to guard against pesticides that coat the crops," and most go home at night to dwellings without air conditioning, so they can't cool

37. Kjellstrom, *supra* note 33, at 224.

38. John P. Dunne et al., *Reductions in Labour Capacity from Heat Stress Under Climate Warming,* 3 NATURE CLIMATE CHANGE 563, 565 (2013); *see also* Geoffrey Heal & Jisung Park, *Goldilocks Economies? Temperature Stress and the Direct Impacts of Climate Change* 11 (Nat'l Bureau of Econ. Res., Working Paper No. 21119, 2015).

39. CLIMATE CHANGE, *supra* note 9, at 28.

40. Riccardo Colacito et al., *Temperature and Growth: A Panel Analysis of the United States*, 28 (Fed. Res. Bank of Richmond, Working Paper No. 18-09, 2018).

41. Kate Larsen et al., *Hotter, Poorer and More Unequal*, RHODIUM GROUP (June 29, 2017), https://rhg.com/research/hotter-poorer-and-more-unequal/.

42. Marshall Burke et al., *Global Non-Linear Effect of Temperature on Economic Production*, 527 NATURE 235, 238 (2015).

43. U.N. DEV. PROGRAM, CLIMATE CHANGE AND LABOUR: IMPACTS OF HEAT IN THE WORKPLACE 27 (Matthew McKinnon et al., eds. 2016).

44. Heal & Park, *supra* note 38, at 12.

45. Scott Waldman, *Precarious Life of Texas Farmworkers Becomes Riskier with Warming*, SCI. AM. (Apr. 23, 2018), https://www.scientificamerican.com/article/precarious-life-of-texas-farmworkers-becomes-riskier-with-warming/.

off.[46] Upwards of half of them are undocumented, so they are reluctant to complain or seek help.[47]

The economic costs of climate change in the United States will not be the same everywhere. As Kate Larsen and colleagues found:

> States in the South and lower Midwest, which tend to be poor and hot already, have the most to lose, while some parts of New England and the Northwest could see net gains . . . . Increased heat-related mortality, declining crop yields, and reduced labor productivity across the South could devastate local economies. Colder and richer counties along the northern border and in the Rockies may actually benefit, as health, agriculture yields, and energy costs improve due to a reduction in the number of extremely cold days.[48]

D. Vulnerable Populations

Outside of the occupational context, various factors make some people especially vulnerable to extreme heat. Some of them relate to how their bodies are affected by heat, such being over the age of 65; having pre-existing cardiovascular or respiratory illnesses, diabetes, obesity, or certain psychiatric disorders; and taking certain medications. Others reduce a person's ability to cope with heat: living alone; having poor English skills, less than a high school diploma, or limited mobility; being African American; and, of course, lacking or losing air conditioning.[49]

Often several of these factors exist together, sometimes with tragic results. The best-known example in the United States was the 1995 heat wave in Chicago, which killed more than 1,000 people.[50] In his study of this event, sociologist Eric Klinenberg found:

> For the most part, the geography of heat-wave mortality was consistent with the city's geography of segregation and inequality: eight of the ten community areas with the highest death rates were virtually all African American, with pockets of concentrated poverty and violent crime,

---

46. *Id.*

47. Nathalie Baptiste, *Farmworkers Are Dying from Extreme Heat*, MOTHER JONES (Aug. 24, 2018), https://www.motherjones.com/food/2018/08/farmworkers-are-dying-from-extreme-heat/.

48. Larsen et al., *supra* note 41.

49. Kathryn Bradford et al., *A Heat Vulnerability Index and Adaptation Solutions for Pittsburgh, Pennsylvania*, 49 ENVTL. SCI. & TECH. 11303, 11306 (2015); Joyce Klein Rosenthal et al., *Intra-Urban Vulnerability to Heat-Related Mortality in New York City, 1997-2006*, 30 HEALTH & PLACE 45, 45–47 (2014); Hajat et al., *supra* note 16, at 858; N.Y.C. DEP'T. OF HEALTH & MENTAL HYGIENE, *Heat-Related Deaths in New York City, 2013*, EPI DATA BRIEF NO. 47, at 1–2 (Aug., 2014).

50. Hosmay Lopez et al., *Early Emergence of Anthropogenically Forced Heat Waves in the Western United States and Great Lakes*, 8 NATURE CLIMATE CHANGE 414, 414 (2018).

> places where old people were at risk of hunkering down at home and dying alone during the heat wave. But that's not the whole story. Three of the ten neighborhoods with the lowest heat-wave death rates were also poor, violent, and predominantly African American. Which means that neither race, nor ethnic cultural practices and values, nor violence or poverty are sufficient to explain who lived and who died that week.[51]

The principal difference between demographically similar neighborhoods with high and low death rates was what Klinenberg called the "social infrastructure"—"the sidewalks, stores, public facilities, and community organizations that bring people into contact with friends and neighbors."[52] In some neighborhoods, residents "knew their neighbors. They participated in block clubs and church groups. . . . [D]uring the heat wave they knew who was alone, who was old, and who was sick. They did wellness checks and encouraged neighbors to knock on each other's doors—not because the heat wave was so exceptional, but because that's what they always do when the weather is extreme."[53] In other neighborhoods, however, people died alone and forgotten.[54]

A remarkably similar pattern was found in Paris after the European heat wave of 2003, which killed about 70,000 people. There, too, as found by medical historian Richard C. Keller, the disaster

> inflicted the greatest damage on the poorest and most isolated populations in France. They are the so-called abandoned or forgotten victims of the disaster, whose bodies remained unclaimed by family. They are those who died (and to a great extent lived) unnoticed by their neighbors, only discovered in some cases weeks after their deaths.[55]

III. AIR CONDITIONING

Air conditioning would seem to be the cure-all for the health impacts of excess heat. If everyone could spend all day in air-conditioned rooms or vehicles whenever it is hot, no one would get sick or die from the heat. But it is not that simple—and not only because so many people must work outside.

---

51. ERIC KLINENBERG, HEAT WAVE: A SOCIAL AUTOPSY OF DISASTER IN CHICAGO xxiii (2d ed. 2015).
52. *Id.* at xxiv.
53. *Id*.
54. *Id.* at 15.
55. RICHARD C. KELLER, FATAL ISOLATION: THE DEVASTATING PARIS HEAT WAVE OF 2003, at 2 (2015).

A. History of Air Conditioning

For millennia, people lived in hot places without air conditioning. Thick walls of adobe, stone, or brick and small windows provided thermal insulation. Some houses were dug partly underground to keep cool (the dwelling on Tatooine of Luke Skywalker's unfortunate Uncle Owen and Aunt Beru was actually a traditional underground house in southern Tunisia[56]). Windows and doors were aligned for cross-drafts.[57] Porches and awnings kept the sun out while allowing windows to stay open.[58] The larger homes of the affluent, and later their apartment and office buildings, had courtyards to help airflow and high ceilings so the heat could rise. Ventilation was the original function of transoms over doors (now best known as the delivery portals for unsolicited manuscripts and resumes).[59]

In reaction to gloomy tenements, New York City adopted a law in 1901 requiring that all apartments have access to natural light and fresh air (and thus cooling ventilation). An unintended consequence was that children started falling out of windows—often around 100 a year—so the city eventually adopted another law requiring landlords to provide window guards for units with young kids, and later making it a crime if they did not.[60]

Air conditioning did not come into commercial use until the late 19th and early 20th century, and then only for machines, not people.[61] The

56. Reuters, *The Last Inhabitants of Tunisia's Centuries Old Underground Homes: Only a Handful of Families Remain Living in the Ancient Caves after Government Builds Wave of New Homes*, DAILY MAIL (Feb. 23, 2018), https://www.dailymail.co.uk/news/article-5426499/Future-Tunisias-famous-underground-houses-jeopardy.html.

57. *See generally* Robert Khederian, *How Houses Were Cooled Before Air Conditioning*, CURBED (July 20, 2017), https://www.curbed.com/2017/7/20/16003184/old-houses-air-conditioning-summer. This article discusses various architectural designs that address climatic conditions. *See also Ways That Architecture was Designed to Fight Summer Heat*, NEW ORLEANS ARCHITECTURE TOURS (Aug. 7, 2017), https://nolatours.com/summer-heat/.

58. *Id.*

59. *Id.*

60. Amita Toprani, et al., *New York City's Window Guard Policy: Four Decades of Success*, 24 INJURY PREVENTION, at i14-i18 (2018); CITY OF N.Y. OFFICE OF THE MAYOR, COOL NEIGHBORHOODS NYC: A COMPREHENSIVE APPROACH TO KEEP COMMUNITIES SAFE IN EXTREME HEAT 29-30 (2017) [hereinafter COOL NEIGHBORHOODS NYC]; Cait Etherington, *A Short History of New York City's Foul Air Shafts*, 6SQFT (Oct. 16, 2017), https://www.6sqft.com/a-short-history-of-new-york-citys-foul-air-shafts/.

61. For the history of air conditioning, *see* STAN COX, LOSING OUR COOL: UNCOMFORTABLE TRUTHS ABOUT OUR AIR-CONDITIONED WORLD (AND FINDING NEW WAYS TO GET THROUGH THE SUMMER) (The New Press, 2010); GAIL COOPER, AIR-CONDITIONING AMERICA: ENGINEERS AND THE CONTROLLED ENVIRONMENT, 1900–1960, 17–23, 30, 49, 55 (Johns Hopkins Univ. Press 1998); MARSHA E. ACKERMANN, COOL COMFORT: AMERICA'S ROMANCE WITH AIR-CONDITIONING (Ruth W. Spiegel, ed., Smithsonian Inst. 2010) (2002).

manufacture of various items benefitted from the control of heat and humidity—textiles, printing, chocolate, tobacco, pasta, sausage, black powder, chewing gum, candy, flour, leather, rayon, photographic film, gelatin capsules—and new applications were continually being found. The technology allowed factories to locate in places that the weather had previously made unsuitable. Air conditioning systems were installed in 1924 in the Palace Theatre in Dallas, in the Texan and Iris theaters in Houston,[62] and in 1925 in the Rivoli Theater in New York's Times Square, first exposing the public to this wonder.[63] The Chambers of the Senate and the House of Representatives, the White House, and the Supreme Court were air conditioned between 1929 and 1931.[64] In the 1930s, a few very rich families began installing it in their homes.[65]

Production of this luxury item was halted during World War II, but after the war, it took off. Air conditioning became standard in mass-produced wooden homes for returning soldiers in sweltering cities, such as Phoenix.[66] The prehistoric Hohokam people—perhaps as many as 60,000 of them—lived in what is now Arizona for more than a thousand years, but their adobe dwellings and pit houses (houses built into the ground) were not suitable for mass production.[67]

A cultural shift was happening. As Marsha Ackermann has written, the industry realized:

> [T]he ascendancy of air-conditioning would require persuasion. A significant portion of the American public needed to believe that heat was not just an occasional unpleasantness but a serious problem; that this problem could be corrected; and that uniform control of indoor thermal conditions in all weathers, seasons, and climatic regions was the birthright of a truly advanced society.[68]

And the American public was persuaded Central air became standard in many new residential and commercial buildings, and window air conditioners were installed in older ones, shielding occupants from the

62. Raymond Arsenault, *The End of the Long Hot Summer: The Air Conditioner and Southern Culture*, 50 J. S. HIST. 597, 603 (1984).

63. Katie Herzog, *How Air-Conditioning Made America—And How it Could Break Us All*, GRIST (July 26, 2016), https://grist.org/food/how-air-conditioning-made-america-and-how-it-could-break-us-all/.

64. *See* Arsenault, *supra* note 62 at 605.

65. *See* Herzog, *supra* note 63.

66. *Id.*

67. *See id.*; Ariz. Geographic All., *Who Were the Hohokam?*, ARIZ. ST. UNIV., https://geoalliance.asu.edu/sites/default/files/LessonFiles/Barker/Hohokam/BarkerHohokamS.pdf (last visited Nov. 4, 2018).

68. *See* ACKERMANN, *supra* note 61, at 9.

breezes, smells, and noises of the outside world.[69] In 1955, the General Services Administration decreed that all new federal buildings outside the northernmost regions have air conditioning.[70] Organized labor noticed all this, and in 1968, Teamsters Union boss, Jimmy Hoffa, demanded air-conditioned truck cabs on all long-distance southern runs.[71] Openable windows in office buildings became obsolete, especially after the energy crises of the 1970s led to tight buildings as a way (it seemed) of saving energy.[72] Office buildings assumed the shape of solid boxes with large windows, which allowed beautiful views outward and hot sun streaming inward, magnifying the air conditioning load.[73] The steamy south blossomed with rapidly expanding cities, whose residents spent their working and sleeping hours (and most others), as well as their drive time, in the artificial cold.[74]

For about half of the population, offices are too cold; in many buildings the temperature settings are based on a thermal comfort model that was developed in the 1960s based on the metabolic rate of the average male, which is up to 35% higher than that of the average female.[75] That's why many women wear sweaters or use space heaters in their offices in July.[76] At home, dual control electric blankets address different individuals' heat sensitivities in the winter.

B. Prevalence and Growth

Today 87% of U.S. homes have air conditioning.[77] The nation's least air-conditioned big city is Seattle, lying on the cool Puget Sound, where only one-third of the houses (mostly those of the richest) have it. A heat wave in July 2018 made many of the remaining two-thirds rethink their

---

69. *See* COOPER, *supra* note 61, at 1–2.

70. *Id.* at 163.

71. Arsenault, *supra* note 62, at 613.

72. Mary Guzowski, *The "Costs" of Operable Windows: On the Question of Operable Windows in Cold Climate Design*, ENVTL. DESIGN RES. ASS'N CONF. 1 (2003), http://arch.design.umn.edu/directory/guzowskim/documents/16.EDRA-newlayoutfinal6.9.pdf; LYNN BEADLE, TALL BUILDINGS AND URBAN HABITAT: CITIES IN THE THIRD MILLENNIUM 578 (Spoon Press, 2001).

73. Richard Dahl, *Cooling Concepts: Alternatives to Air Conditioning for a Warm World*, 121 ENVTL. HEALTH PERSP., Jan. 2013, at A18.

74. Emily Badger & Alan Blinder, *How Air-Conditioning Conquered America (Even the Pacific Northwest)*, N.Y. TIMES, Aug. 4, 2017.

75. Boris Kingma & Wouter van Marken Lichtenbelt, *Energy Consumption in Buildings and Female Thermal Demand*, 5 NATURE CLIMATE CHANGE 1054, 1054 (2015).

76. *Id.*

77. Danni Mayclin, *Air Conditioning Accounts for 12% of U.S. Home Energy Expenditures*, U.S. ENERGY INFO. ADMIN. (July 23, 2018), https://www.eia.gov/todayinenergy/detail .php?id=36692.

choice.[78] Just 150 miles south, in Portland, Oregon, 70% of houses have air conditioning.[79]

Some other countries are catching up fast. Since 1990, annual global sales of air conditioners more than tripled to 135 million units.[80] There are now about 1.6 billion in use, with over half in just the United States and China.[81] The amount of energy used for space cooling could triple by 2050, with around half of this growth expected in China, India and Indonesia.[82]

C. Energy and Environmental Impacts

All this artificial cooling consumes massive amounts of energy. In the United States, 17% of residential electricity consumption is spent on air conditioning,[83] but on the hottest days, in places it can be 70%[84] and it is the main driver of annual peak electric demand.[85] Current U.S. electricity consumption for space cooling is more power than the 1.1 billion people in Africa use for everything.[86]

Globally, annual energy demand for cooling could go from the current 3,900 terawatt hours to 7,500 or higher.[87] 7,500 terawatt hours is more

---

78. Chris Dolce, *The Nation's Least Air-Conditioned City is Having One of Its Hottest Julys on Record*, WEATHER CHANNEL (July 25, 2018), https://weather.com/news/news/2018-07-25-seattle-washington-hot-july-least-air-conditioned/.

79. U.S. ENERGY INFO. ADMIN., RESIDENTIAL ENERGY CONSUMPTION SURVEY (RECS) (2015), https://www.eia.gov/consumption/residential/data/2015/pdf/microdata.pdf.

80. Unless otherwise noted, the information in this and the next two paragraphs is drawn from INT'L ENERGY AGENCY, THE FUTURE OF COOLING: OPPORTUNITIES FOR ENERGY-EFFICIENT AIR CONDITIONING 12 (2018), https://emis.vito.be/sites/emis.vito.be/files/articles/3331/2018/The_Future_of_Cooling.pdf [hereinafter THE FUTURE OF COOLING]; Toby Peters et al., *A Cool World: Defining the Energy Conundrum of Cooling for All*, BIRMINGHAM ENERGY INST. & INST. FOR GLOB. INNOVATION (2018), https://www.birmingham.ac.uk/Documents/college-eps/energy/Publications/2018-clean-cold-report.pdf.

81. THE FUTURE OF COOLING, *supra* note 80, at 11.

82. *Id.*

83. Maggie Woodward & Chip Berry, *Residential Electricity by End Use, 2015*, U.S. ENERGY INFO. ADMIN. (June 5, 2018), https://www.eia.gov/todayinenergy/detail.php?id=36412&src=%E2%80%B9%20Consumption%20%20%20%20%20%20Residential%20Energy%20Consumption%20Survey%20(RECS)-b1.

84. THE FUTURE OF COOLING, *supra* note 80.

85. Luis Ortiz et al., *Climate Change Impacts on Peak Building Cooling Energy Demand in a Coastal Megacity*, 13 ENVTL. RES. LETTERS 094008, at 1 (2018), http://iopscience .iop.org/article/10.1088/1748-9326/aad8d0/pdf.

86. CHILLING PROSPECTS: PROVIDING SUSTAINABLE COOLING FOR ALL, SUSTAINABLE ENERGY FOR ALL & KIGALI COOLING EFFICIENCY PROGRAM 9 (2018), https://www.seforall.org/sites/default/files/SEforALL_CoolingForAll-Report.pdf.

87. Peters et al., *supra* note 80, at 3.

electricity than the entire world consumed in 1980,[88] and about double what the United States used in 2017.[89] But even with this drastic increase, most people in the world's hottest places still lack air conditioning, as well as refrigeration.[90] As of now, of the 2.8 billion people living in the hottest places in the world, only 8% have air conditioning.[91] The lack of artificial cold also leads to massive spoilage of food and medicine in the poorest countries.[92] If everyone in the hottest places had adequate cooling, total energy consumption for cooling could decrease to 19,600 terawatts by 2050.[93]

Generating and using all this electricity with current technologies would, in itself, drive up air pollution and kill or sicken many people.[94] It would also swell the use of hydrofluorocarbons (HFCs), which are very powerful greenhouse gases used in refrigeration. HFCs themselves are substitutes for other classes of chemicals, especially chlorofluorocarbons (CFCs), which deplete the ozone layer as well as harm the climate.[95] The Montreal Protocol on Substances That Deplete the Ozone Layer of 1987 requires the phaseout of CFCs and their chemical kin, unfortunately leading to massive use of HFCs.[96] Because HFCs are such a threat to the climate, in 2016, the countries of the world convened in Kigali, Rwanda, and agreed to amend the Montreal Protocol to phase out HFCs as well.[97] India led a successful effort by several hot countries to obtain for themselves a delay to 2029 in starting and 2047 in completing their phaseout, so that they might still install air conditioning for their scorched hundreds of millions of people using today's technologies.[98] Meanwhile, U.S. efforts to phase out HFCs

88. *Consumption of Electricity Worldwide from 1980 to 2015 (in Billion Kilowatt Hours)*, STATISTA, https://www.statista.com/statistics/280704/world-power-consumption/ (last visited Feb. 16, 2019).

89. *Total Electricity End Use in the U.S. from 1975 to 2017 (in Billion Kilowatt Hours)*, STATISTA, https://www.statista.com/statistics/201794/us-electricity-consumption-since-1975/ (last visited Feb. 16, 2018).

90. Peters et al., *supra* note 80, at 4.

91. THE FUTURE OF COOLING, *supra* note 80, at 11.

92. Peters et al., *supra* note 80, at 3.

93. *Id.* at 4.

94. David W. Abel et al., *Air-Quality-Related Health Impacts from Climate Change and from Adaptation of Cooling Demand for Buildings in the Eastern United States: An Interdisciplinary Modeling Study*, PLoS MED. (July 3, 2018), https://journals.plos.org/ plosmedicine /article?id=10.1371/journal.pmed.1002599.

95. Kristin H. Gladd, *U.S. Refrigerant Regulation and Climate Change*, 32 WTR NAT. RESOURCES & ENV'T 48 (2018).

96. *Id.*

97. *Id.* at 48–50.

98. April Reese, *Slow Coolant Phaseout Could Worsen Warming*, 359 SCIENCE 1084, 1084 (2018); Ellen Barry & Coral Davenport, *Emerging Climate Accord Could Push A/C Out of Sweltering India's Reach*, N.Y. TIMES (Oct. 12, 2016), https://www.nytimes.com/2016 /10/13/world/asia/india-air-conditioning.html.

were slowed down in 2017 when the U.S. Court of Appeals for the District of Columbia Circuit, in a 2-1 decision written by Judge Brett Kavanaugh, struck down an EPA regulation on HFCs based on a very narrow reading of the Clean Air Act.[99]

There is an optimum strategy for achieving the three sometimes battling objectives of reducing greenhouse gas emissions in accordance with the Paris Climate Agreement, reducing HFC use to comply with the Kigali Agreement, and providing energy access to the poorest people as sought by the UN Sustainable Development Goals. The strategy is to massively improve the efficiency of air conditioning while at the same time transitioning away from HFCs, so that cooling can be provided with minimal environmental impact and operating cost.[100] Several groups have formed to drive these improvements.[101] Of the legal tools available to help achieve this, the most important is probably stricter energy efficiency standards for air conditioners and other equipment. The United States strengthened its standards in 2017, but they still fall short.[102] The average air conditioner sold in the United States is less efficient than the average sold in Europe, Japan, South Korea, and China. The United States has the most efficient air conditioners available for sale anywhere, but they are not legally required, and they only get about 3% of the market.[103] These devices cost more up front; they save money in monthly electric bills, but it can take many years to pay for themselves this way, especially in places with low electric rates.

Developing affordable and highly efficient cooling devices is a pressing technological challenge. By one estimate, cooling is now responsible for about 10% of worldwide greenhouse gas emissions, and growing rapidly.[104] A UN-associated group has concluded that there are "2.3 billion people in the increasingly affluent lower middle class in the developing countries who are on the brink of purchasing the most affordable—and therefore likely least efficient—air conditioners."[105] They

99. *See* Mexichem Fluor, Inc. v. Envtl. Prot. Agency, 866 F.3d 451 (D.C. Cir. 2017).

100. *See* NIHAR SHAH ET AL., ENERGY ANALYSIS & ENVTL. IMPACTS DIV., LAWRENCE BERKELEY NAT'L LAB., OPPORTUNITIES FOR SIMULTANEOUS EFFICIENCY IMPROVEMENT AND REFRIGERANT TRANSITION IN AIR CONDITIONING (2017), https://ies.lbl.gov/publications /opportunities-simultaneous-efficiency.

101. *See* CHILLING PROSPECTS, *supra* note 86; ACCELERATING THE GLOBAL ADOPTION OF ENERGY-EFFICIENT AND CLIMATE-FRIENDLY AIR CONDITIONERS, U.N. ENV'T PROGRAMME (2017), https://united4efficiency.org/wp-content/uploads/2017/06/U4E-ACGuide-201705-Final.pdf.

102. AM. COUNCIL FOR AN ENERGY-EFFICIENT ECON., 2019 EFFICIENCY PROGRAMS: PROMOTING HIGH EFFICIENCY RESIDENTIAL AIR CONDITIONERS AND HEAT PUMPS 1 (2018).

103. *Id.* at 1–2; THE FUTURE OF COOLING, *supra* note 80, at 44, fig.2.3.

104. CHILLING PROSPECTS, *supra* note 86, at 44.

105. CHILLING PROSPECTS, *supra* note 86, at 8.

are mostly city dwellers in countries like China, India, Indonesia and Brazil.[106] Without much better efficiency in the units and the buildings where they will go, electricity demand could soar.[107] Several new technologies are being tested to provide cooling with little or no power, such as solar thermal chillers,[108] panels with ultrathin metal oxide layers,[109] heat recovery, ice storage,[110] and others. However, none is yet commercially competitive.

D. Cost

Cost is a major factor keeping people from acquiring or using air conditioning units, even in the United States. Affluent households are more likely to have units than poor ones, and owners are more likely to have them than renters.[111] Many poor people who do have units cannot afford the electricity to run them.[112] The power for home air conditioning costs $265/year on average ($525 in the hot and humid Southeast).[113] The federal Low Income Home Energy Assistance Program mostly provides limited money to help low-income families heat their homes in the winter; very little goes for cooling, and in most states even that assistance is limited to buying air conditioners, not to operating them.[114] Several states do have rules prohibiting utilities from cutting off residential electric or gas service due to nonpayment of bills during times of extreme heat.[115]

106. CHILLING PROSPECTS, *supra* note 86, at 9.

107. CHILLING PROSPECTS, *supra* note 86, at 9.

108. XiaoZhi Lim, *Cooling With Heat: As Demand for Air Conditioning Climbs, Some See a Solution in the Very Thing that Makes us Sweat: The Sun.,* 542 NATURE 23, 23 (2017).

109. Prachi Patel, *New cooling method literally sends heat out of this world*, ANTHROPOCENE (Sept. 7, 2017), http://www.anthropocenemagazine.org/2017/09/new-cooling-method-literally-sends-heat-out-of-this-world/?fbclid=IwAR3c-wpgSomO47j8Ej2Lbbh5wPj6M4NQ_qYzisiSC1vDi65KXhVZy75hbHM.

110. Mark Chediak, *A California Startup That Cools With Ice Raises $40 Million*, BLOOMBERG (June 26, 2018), https://www.bloomberg.com/news/articles/2018-06-26/a-california-startup-that-cools-with-ice-raises-40-million.

111. RESIDENTIAL ENERGY CONSUMPTION SURVEY, *supra* note 79.

112. Rosenthal, *supra* note 49, at 56.

113. Mayclin, *supra* note 77.

114. COOL NEIGHBORHOODS NYC, *supra* note 60, at 27; Ann E. Carlson, *Heat Waves, Global Warming, and Mitigation*, 26 UCLA J. ENVTL. L. & POL'Y 169, 209–10 (2008).

115. *E.g.*, *Hot Weather Law*, MO. PUB. SERV. COMM'N, https://psc.mo.gov/General/Hot_Weather_Law_2018 (last visited Dec. 27, 2018); *State Disconnection Policies*, LIHEAP CLEARINGHOUSE, https://liheapch.acf.hhs.gov/Disconnect/disconnect.htm (last visited Dec. 27, 2018).

IV. HEAT ISLANDS, TREES, AND ROOFS

Air conditioning makes buildings cool on the inside by transferring the heat to the outside. Dark pavement and rooftops, cement, and other artificial surfaces of a city absorb the heat of the sun. Soil that has been paved over can no longer retain and then evaporate water, which has a cooling effect.[116]

All these factors lead to the urban heat island effect. Many U.S. cities and suburbs are up to 10°F warmer than the surrounding countryside.[117] While urban density is environmentally positive in many ways—it helps make mass transit feasible, consumes less land, allows for more energy efficient buildings—the heat island effect is a negative. Cities have many microclimates; the temperature can change several degrees in just a few blocks, depending mostly on whether the neighborhood is entirely buildings and pavement, or whether it has ample trees and other vegetation.[118] This is correlated with income—in many cities, more affluent districts have more greenery and are cooler. One study estimated that "mean surface temperature in census tracts decreased by 0.5°F for every $10,000 increase in median income for a summer day in Phoenix . . . In other words, affluent people 'buy' more favorable microclimates."[119] In contrast, poor neighborhoods—disproportionately minority—have higher temperatures and less air conditioning.

Climate change does not cause the urban heat island effect, but it worsens it by raising the baseline from which these temperature increases occur. Buildings and pavement also store heat and reduce nighttime cooling.[120]

The urban heat island effect has local origins, and it also has two local partial solutions: trees and roofs. With respect to trees, on hot days it may be up to 45°F cooler in the shade than in the open; and evapotranspiration from trees can reduce peak temperatures by 2–9°F.[121] Roofs typically occupy 20-

---

116. Jilliam C. Kirn, *Mitigation of Urban Heat Islands: Greening Cities with Mandates versus Incentives*, 32 NAT. RESOURCES & ENV'T 40, 40–43 (2018).

117. ENVTL. PROT. AGENCY, COOLING SUMMERTIME TEMPERATURES: STRATEGIES TO REDUCE URBAN HEAT ISLANDS 2 (2003), https://www.epa.gov/sites/production/files/2014-06/documents/hiribrochure.pdf.

118. *See* Rosenthal, *supra* note 49.

119. Sharon L. Harlan et al., *In the Shade of Affluence: The Inequitable Distribution of the Urban Heat Island*, 15 RES. SOC. PROBS. & PUB. POL'Y 173, 185 (2008).

120. N.Y.C. ENVTL. JUSTICE ALL., NYC CLIMATE JUSTICE AGENDA: MIDWAY TO 2030, at 11 (Apr. 2018).

121. COOL NEIGHBORHOODS NYC, *supra* note 60, at 11; *see also* Dan M. Kurn et al., *The Potential for Reducing Urban Air Temperatures and Energy Consumption Through Vegetative Cooling*, LAWRENCE BERKELEY LAB. (1994), https://heatisland.lbl.gov/ publications /potential-reducing-urban-air.

25% of urban surface area.[122] If half of New York City buildings installed green roofs, the entire city's surface temperature could go down by more than 1°F.[123] If cool roofs were adopted throughout the Los Angeles and San Diego areas, temperatures could drop by 1.6°F.[124]

Improvements of this size make a difference. Models suggest that mortality increases by about 1% per degree (Fahrenheit) for temperatures in the upper 80s, then increases by 2% per degree for temperatures near 90 and by 5% per degree in the mid-90s, and continues to rise rapidly above that level, and even more for the very elderly.[125] A study in India found that an increase of just under 1°F in mean temperatures corresponded to a 146% increase in the probability of large-scale heat mortality events.[126]

Several cities have programs to require or directly undertake tree planting. For instance, Seattle adopted minimum landscaping guidelines in 2007, which demands that certain new developments have 30% vegetative cover.[127] The same year that New York City launched its Million Trees NYC program, it planted its millionth new tree in 2015, two years ahead of schedule.[128] Two years later (in the wake of a heat wave), New York City committed an additional $82 million to plant street trees, especially in areas facing the greatest heat risks.[129] Phoenix imposes tree requirements for common areas around housing developments or commercial sites.[130] Many volunteer organizations run tree planting campaigns. Moreover, planting the trees is only the start; they must be properly maintained. Insects and improper pruning are common threats.[131]

---

122. Danielle Spiegel-Feld & Lauren Sherman, *Expanding Green Roofs in New York City: Towards a Location-Specific Tax Incentive*, 36 NYU ENVTL. L.J. 101, 102 (2018).

123. *Id.* at 116.

124. P. Vahmani et al., *Investigating the Climate Impacts of Urbanization and the Potential for Cool Roofs to Counter Future Climate Change in Southern California*, 11 ENVTL. RES. LETTERS 124027, 7 (2016).

125. MICHAEL BLASNIK, ENERGY COORDINATING AGENCY, IMPACT EVALUATION OF PHILADELPHIA'S COOL HOMES PILOT PROJECT 29 (2004).

126. Omid Mazdiyasni et al., *Increasing Probability of Morality During Indian Heat Waves*, 3 SCI. ADVANCES, June 7, 2017, at 1.

127. Kirn, *supra* note 116, at 43.

128. Unless otherwise noted, the information in this and the next two paragraphs is drawn from THE FUTURE OF COOLING, *supra* note 80, at 12; Peters, *supra* note 80.

129. *Id.*

130. Brandon Loomis, *In Dallas as in Phoenix, People Look to Trees for Relief from Urban Heat Islands*, ARIZ. REPUBLIC, https://www.azcentral.com/story/news/local/arizona-environment/2017/12/29/dallas-phoenix-shade-trees-relief-dangerous-urban-heat-islands/957247001/ (last updated May 23, 2018, 2:13 PM).

131. ERIK NDAYISHIMIYE ET AL., TREEPEOPLE, PUBLIC TREES FOR PUBLIC GOOD: AN ASSESSMENT OF URBAN FORESTRY MANAGEMENT AND PRACTICES IN LOS ANGELES COUNTY 34 (Deborah Bloome et al. eds., 2017).

Dark roofs absorb 90–95% of the sun's heat, whereas cool roofs absorb between a quarter and a half, reflecting the rest.[132] They may simply be painted white or, even better, be made of especially reflective materials. Cool roofs can be 50–60°F cooler than traditional roofs during hot days, lowering the air conditioning load in the building.[133] Hawaii found that painting the roofs of school buildings with a reflective fluid roof coatings system could lower the temperature inside the classrooms by as much as 5°F.[134] Dozens of U.S. cities have programs to encourage, fund or mandate cool roofs. The laws differ in what kinds of buildings they apply to, whether they only concern new buildings or also old ones, whether they provide financial help, and the technical specifications for what a cool roof is.[135] For example, California requires many new commercial buildings to have cool roofs, while the City of Los Angeles goes further and also mandates this for residential buildings, and it gives rebates to owners who install them.[136] At least thirty electric utilities offer such rebates.[137] Some of the programs also include job training for installers. At the low-tech end of the spectrum, an experiment in Hyderabad, India, covered a handful of tin-roofed shacks with white tarpaulin, and it brought down indoor temperatures by at least two degrees.[138] Several building standards give points for cool or green roofs, including the well-known Leadership in Energy and Environmental Design (LEED) program of the U.S. Green Building Council.[139]

---

132. THE FUTURE OF COOLING, *supra* note 80, at 49.

133. CTR. FOR CLIMATE & ENERGY SOLUTIONS, RESILIENCE STRATEGIES FOR EXTREME HEAT 2 (Nov. 2017), https://www.c2es.org/site/assets/uploads/2017/11/resilience-strategies-for-extreme-heat.pdf.

134. *Heat Abatement Program at Public School*, HAW. ST. DEP'T EDUC., http://www.hawaiipublicschools.org/ConnectWithUs/Organization/SchoolFacilities/Pages/Heat-Abatement.aspx (last visited Dec. 27, 2018).

135. *See* RESILIENCE STRATEGIES FOR EXTREME HEAT, *supra* note 133, at 2–4; Kirn, *supra* note 116, at 41.

136. CARA HOROWITZ, BRIGHT ROOFS, BIG CITY: KEEPING L.A. COOL THROUGH AN AGGRESSIVE COOL-ROOF PROGRAM 6 (Oct. 2011), https://law.ucla.edu/centers/environmental-law/emmett-institute-on-climate-change-and-the-environment/publications/bright-roofs-big-city/; L.A. DEP'T OF WATER & POWER & CITY OF L.A. DEP'T OF BLDG & SAFETY, COOL ROOFS: WHAT YOU NEED TO KNOW ABOUT LADWP REBATES AND BUILDING CODE REQUIREMENTS (2015), https://www.ladbs.org/docs/default-source/publications/ordinances/cool-roof-fact-sheet-and-faq.pdf?sfvrsn=10.

137. SARA P. HOVERTER, GEORGETOWN CLIMATE CTR. ADAPTING TO URBAN HEAT: A TOOL KIT FOR LOCAL GOVERNMENTS 18 (Aug. 2012), https://kresge.org/sites/default/files/climate-adaptation-urban-heat.pdf.

138. Somini Sengupta, *In India, Summer Heat May Soon Be Literally Unbearable*, N.Y. TIMES (July 17, 2018), https://www.nytimes.com/2018/07/17/climate/india-heat-wave-summer.html.

139. HOVERTER, *supra* note 137, at 17.

Green roofs are more complicated to install and maintain but do more than white roofs.[140] They are covered with vegetation, have a growing medium like soil, and typically have a waterproof membrane below.[141] They not only help keep the building and the neighborhood cool, but they also filter stormwater.[142] Going perhaps the furthest, Singapore has a regulatory program called Landscaping for Urban Spaces and High-Rises (LUSH), which requires new buildings to include areas of greenery that are equivalent to the size of the development site; these can be at any level and often include luxuriantly planted balconies and vertical green walls.[143] The Singapore government pays up to half of the installation costs of rooftop and vertical greenery.[144] Germany and the cities of Tokyo and Toronto have long required green roofs, but some U.S. cities are catching up.[145] San Francisco took the lead; it requires 15–30% of roof space on most new construction to have solar panels or "living roof" systems.[146] Over strong opposition by the building industry, voters in Denver by a vote of 54.3% approved a law in November 2017 modelled after the San Francisco and Toronto laws; its implementation is already proving controversial, especially its novel requirement that replacement roofs as well as new ones have vegetation or solar panels.[147] New York City adopted a program in 2008 providing a property tax abatement for the cost of installing green roofs, but the amount offered ($5.23 per square foot) was so small that only seven buildings signed up,[148] since installing a green roof on an existing building in New York costs $20–$25 per square foot. New York has another program that covers the full costs, but it requires owners sign a restrictive covenant

---

140. *Using Green Roofs to Reduce Heat Islands*, ENVTL. PROT. AGENCY, https://www.epa.gov/heat-islands/using-green-roofs-reduce-heat-islands (last visited Jan. 24, 2019).

141. *Id.*

142. *Id.*

143. Philip Oldfield, *What Would a Heat-proof City Look Like?*, GUARDIAN (Aug. 15, 2018, 1:00 AM), https://www.theguardian.com/cities/2018/aug/15/what-heat-proof-city-look-like.

144. *Skyrise Greenery Incentive Scheme 2.0*, NAT'L PARKS BD., https://www.nparks.gov.sg/skyrisegreenery/incentive-scheme (last visited Dec. 28, 2018).

145. Kirn, *supra* note 116, at 40–43.

146. *San Francisco Better Roofs*, CITY & CTY. S.F. PLAN. DEP'T, http://sf-planning.org/san-francisco-better-roofs (last updated Jan. 2017).

147. Jon Murray, *As Nation's Strictest Green Roof Law Takes Effect in Denver, Plenty of Uncertainty Swirls Around Voter-Passed Requirements*, DENVER POST (Dec. 31, 2017, 6:00 AM), https://www.denverpost.com/2017/12/31/denver-green-roof-law/; Grace Hood, *Depending How You Look at it, Denver Green Roof Changes are Simpler or More Complex*, COLO. PUB. RADIO NEWS (June 13, 2018), http://www.cpr.org/news/story/depending-how-you-look-at-it-denver-green-roof-changes-are-simpler-or-more-complex.

148. Scott Stringer & Danielle Spiegel-Feld, *Greening the City from the Top Down*, CRAIN'S N. Y. BUS. (July 24, 2018, 12:00 AM), https://www.crainsnewyork.com/article/20180724/OPINION/180729970/greening-the-city-from-the-top-down; Spiegel-Feld & Sherman, *supra* note 122, at 102.

guaranteeing long-term stewardship, limiting the ability to later sell the property; so far, hospitals, universities, and churches—all long-term owners—have been the main participants.[149]

Solar panels and vegetation on rooftops are not necessarily incompatible. In some rooftop configurations, the PV cells are above the plants, but gaps allow some sunlight in.[150]

Dark asphalt is superb at absorbing heat. Several cities are replacing it with lighter-colored pavement.[151] If all the urban and rural roads in the continental United States were converted to reflective pavements, the reduced warming would be the equivalent of taking about 7% of all passenger vehicles off the road.[152] Some new forms of pavement are porous and can absorb stormwater, addressing (as do green roofs) another climate-related problem.[153] Shading by trees would be even better; it is said that Napoleon ordered that major French roads be lined with trees so that his troops could march long distances in the shade.[154]

New York City has issued detailed guidelines for how city-funded capital construction should minimize the urban heat island effect, including light-colored or green roofs; light-colored pavement; trees; allowances for thermal expansion, warping, softening, or other changes to materials; passive ventilation; and backup generators in case of blackouts.[155]

Therefore, there are many things cities can do with their physical form—buildings, vegetation, pavement—to reduce their temperatures. Additional measures are necessary to reduce the impact of these temperatures on their most vulnerable residents, as shown below.

V. COMMUNITY EFFORTS

When a heatwave strikes, people who have air conditioning at home and at work tend to be fine. Then there are the 13% of U.S. households that don't have air conditioning. Out of the 326 million people living in the

---

149. Spiegel-Feld & Sherman, *supra* note 122, at 124.

150. Kirn, *supra* note 116, at 40–43.

151. COOL NEIGHBORHOODS NYC, *supra* note 60, at 16–17.

152. XIN XU ET AL., CLIMATE CHANGE MITIGATION POTENTIAL OF PAVEMENT ALBEDO 1–2 (2018), https://cshub.mit.edu/sites/default/files/documents/ResearchBrief2018_XuAlbedo_FINAL_Linked.pdf.

153. H.M. Imran, *Permeable Pavement and Stormwater Management Systems: A Review*, 34 J. ENVTL. TECH. 2649, 2649 (2013).

154. Alex Ledsom, *Why France Has its Iconic Tree-Lined Roads*, CULTURE TRIP, (Dec. 7, 2017), https://theculturetrip.com/europe/france/articles/why-france-has-its-iconic-tree-lined-roads/.

155. N.Y.C. MAYOR'S OFFICE OF RECOVERY & RESILIENCY, CLIMATE RESILIENCY DESIGN GUIDELINES 10–14 (2018), https://www1.nyc.gov/assets/orr/pdf/NYC_Climate_Resiliency_Design_Guidelines_v2-0.pdf.

United States, a large number live in places that sometimes experience heat waves. Those who do not have air conditioning at home may have several options. Most probably have friends and family who will take them in during the worst of it. Some cities have established "cooling centers," which are places with air conditioning that have agreed in advance to let people in on the hottest days such as public libraries, schools, community rooms in public housing, and senior centers.[156] Most of the cooling centers close at night, and many do not allow pets, which is an issue for people who do not want to leave their beloved dog(s) or cat(s) alone in a stifling home all day.[157]

Most cities with cooling centers have web sites to help find the nearest one. The City of Paris has created an app, Extrema Paris, identifying cool places to go on hot days (meaning low temperature, not fashionable, though maybe that too).[158] There are similar apps for Athens, Rotterdam and, interestingly, Mallorca.[159] Heat warnings and cooling center information can be sent out via e-mail, text messages, and social media. The bigger problem is for people without the mobility or inclination to go to a cooling center, and who are not connected electronically—typically the elderly and people with various medical and psychological problems, especially if they live alone. As was seen in Chicago in 1995 and Paris in 2003, these are the people most likely to die in heat waves.[160] Young children can also be endangered by heat, even though they do not live alone. Some community groups or tenant associations have set up systems to identify and check in on their vulnerable neighbors. A few city governments have tried to make this more formal, working with social service agencies, home health agencies, and others.[161]

Particularly prominent is the Philadelphia Hot Weather-Health Watch/Warning System. It includes collaboration with community groups, a program to enlist volunteers to visit elderly people daily during heat waves,

---

156. COOL NEIGHBORHOODS NYC, *supra* note 60, at 31.

157. *E.g.*, Renetta DuBose, *Woman with Dog Trying to Beat the Heat Finds Cooling Centers Not So "Cool" About Pets*, WJBF, (July 21, 2016, 5:26 PM), https://www.wjbf.com/news/woman-with-dog-trying-to-beat-the-heat-finds-cooling-centers-not-so-cool-about-pets/1015975195.

158. *Paris Launches App to Help People Keep Cool During Summer Heat*, THE LOCAL, (June 29, 2018, 11:39 AM), https://www.thelocal.fr/20180629/paris-launches-app-to-help-people-keep-cool-during-summer-heat.

159. *Id.*

160. KLINENBERG, *supra* note 51; KELLER, *supra* note 55; *see also* Sabrina McCormick, *Dying of the Heat: Diagnostic Debates, Calculations of Risk, and Actions to Advance Preparedness*, 42 ENV'T & PLAN. 1513 (2010).

161. COOL NEIGHBORHOODS NYC, *supra* note 60, at 37; Justine Calma, *Heat Check*, GRIST, (July 11, 2018), https://gnst.org/article/heat-check/; Carlson, *supra* note 114, at 211–14.

engagement with the media to get the word out about risks and resources, and a widely publicized "heatline" telephone number including a large display seen over much of the center of the city.[162] Philadelphia's system has been documented to save many lives during heat waves.[163]

VI. REGULATING HEAT

When it comes to setting permissible levels of heat, there are guidelines galore, but very few binding, enforceable rules. The statute creating the Occupational Safety and Health Administration (OSHA) gives it the power to set health and safety standards[164] that would require employers "to provide safe or healthful employment."[165] In 1972, shortly after its creation, the National Institute for Occupational Safety and Health (NIOSH), a research agency within the Centers for Disease Control and Prevention, recommended that the new OSHA adopt an occupational heat standard.[166] However, OSHA did not do so. In 1986, NIOSH issued a "criteria document" for what such a standard might look like, but OSHA took little action beyond issuing with NIOSH a three-page "info sheet" on heat illness in 2011.[167] That year, a group called Public Citizen petitioned OSHA to issue a formal standard; however, OSHA refused, declaring that there was not the requisite "grave danger."[168] NIOSH updated its criteria document in 2016. NIOSH can only urge employers to take precautions and educate workers but cannot force them. In July 2018, Public Citizen petitioned OSHA again, this time joined by 130 other organizations and 93 individuals.[169] Hopes are not high that the Trump administration will act.

---

162. WORLD METEOROLOGICAL ORGANIZATION & WORLD HEALTH ORGANIZATION, HEATWAVES AND HEALTH: GUIDANCE ON WARMING-SYSTEM DEVELOPMENT 53 (G.R. McGregor et al. eds., 2015).

163. Kristie L. Ebi et al., *Heat Watch/Warning Systems Save Lives: Estimated Costs and Benefits for Philadelphia 1995–98*, 85 AM. METEOROLOGICAL SOC'Y, Aug. 2004, at 1067 (2004); Hajat et al., *supra* note 16.

164. 29 U.S.C. § 655 (2018).

165. 29 U.S.C. § 652(8) (2018).

166. Sidney Shapiro & Katherine Tracy, *Occupational health and safety law*, *in* RES. HANDBOOK CLIMATE DISASTER L. 148, 154 (Rosemary Lyster & Robert V.M. Verchick, eds., 2018).

167. PROTECTING WORKERS FROM HEAT ILLNESS, OCCUPATIONAL SAFETY & HEALTH ADMIN. 3 (2011), https://www.osha.gov/Publications/osha-niosh-heat-illness-infosheet.pdf.

168. Letter from David Michaels, Assistant Secretary, Occupational Safety and Health Administration, to Sidney Wolfe, Director, Public Citizens Health Research Group (June 7, 2012).

169. PUBLIC CITIZEN ET AL., PETITION TO OSHA FOR A HEAT STANDARD (July 17, 2018), https://citizenvox.org/wp-content/uploads/2018/07/180717_Petition-to-OSHA-on-Heat-Stress-Signed_FINAL.pdf.

OSHA's statute also has a "general duty clause" that says each employer must furnish conditions "which are free from recognized hazards that are causing or are likely to cause death or serious physical harm."[170] Under this authority, OSHA has issued regulations on personal protective equipment[171] and on drinking water for employees,[172] but there are few other binding rules on heat. OSHA also has a technical manual with a detailed section about heat stress and a Heat Illness Prevention Campaign, but these are only advisory.[173]

States may adopt their own programs for occupational safety and health, provided they are at least as stringent as OSHA's.[174] Twenty-eight have done so.[175] Three of them have rules on heat exposure: California, Washington and Minnesota.[176] California has gone the furthest; it has outdoor standards and, as mandated by its state legislature, appears to be on the verge of adopting indoor standards.[177] The outdoor standards include provisions on drinking water, access to shade, high-heat procedures for when it's at least 95°F, emergency response rules, acclimatization, training, and heat illness prevention plans.[178] As one sign of the difference in California's enforcement of heat rules vs. OSHA's, between 2013 and 2017, California completed 7,082 inspections resulting in at least one heat violation—fifty times as many inspections as OSHA's nationwide 142 under the general duty clause.[179]

---

170. 29 U.S.C. § 654(a)(1) (2012).

171. 29 C.F.R. §§ 1910.132(d)(1), 1915.152(a), 1917.95, and 1926.28(a) (establishing protective equipment regulations in general and for employers in the shipyard, maritime, and construction industries, respectively).

172. 29 C.F.R. §§ 1910.141(b), 1915.88(b), 1917.127(b), 1918.95(b), 1926.51(a), and 1928.110(c)(1) (establishing potable water regulations in general and for employers in the shipyard, maritime, longshoring, construction, and industries, respectively).

173. *Section III: Chapter 4—Heat Stress of OSHA Technical Manual*, OCCUPATIONAL SAFETY & HEALTH ADMIN., https://www.osha.gov/dts/osta/otm/otm_iii/otm_iii_4.html (last updated Sept. 15, 2017).

174. 29 U.S.C. § 667 (2012).

175. *State Plans*, OCCUPATIONAL SAFETY & HEALTH ADMIN., https://www.osha.gov/dcsp /osp/index.html (last visited Jan. 28, 2019).

176. PUBLIC CITIZEN, ET AL., PETITION TO OSHA FOR A HEAT STANDARD 1 (July 17, 2018), https://citizenvox.org/wp-content/uploads/2018/07/180717_Petition-to-OSHA-on-Heat-Stress-Signed_FINAL.pdf.

177. *See Heat Illness Prevention in Indoor Places of Employment: Advisory Meetings,* CAL. DEP'T INDUS. REL. (2018), https://www.dir.ca.gov/dosh/doshreg/heat-illness-prevention-indoors/.

178. CAL. CODE REGS. tit. 8, § 3395 (2015).

179. Letter from Public Citizen, to Loren Sweatt, Acting Assistant Sec'y of Labor, Occupational Safety and Health Administration, at 17–18 (July 17, 2018), https://www.citizenvox.org/wp-content/uploads/2018/07/180717_Petition-to-OSHA-on-Heat-Stress-Signed_FINAL.pdf.

Various non-governmental groups have also developed their own voluntary standards on worker exposure to heat, including the National Fire Protection Association[180] and the International Association of Fire Fighters.[181] There are also guidelines for student athletes.[182] Nonetheless, two or three football players, mostly high school students, die every year of heat stroke.[183] Most could be saved by the use of heat stress monitors and cooling tubs (which allow afflicted players to be dunked in ice), but few places require those.[184]

Special rules apply to particular categories of people who are exposed to heat. Below are several examples.[185]

A. Tenants

In almost every state, residential leases are legally deemed to include an "implied warranty of habitability," meaning that the apartment or house is livable, safe, and clean.[186] This means that heat must always be provided when it is cold.[187] It rarely means that there has to be air conditioning when it's hot, but if the landlord has provided an air conditioner, it should be in working order.[188] An exception is Phoenix, where the city code requires

---

180. THERMAL HEAT STRESS PROTOCOL FOR FIRE FIGHTERS AND HAZMAT RESPONDERS, INT'L ASS'N. FIRE FIGHTERS 1, http://www.iaff.org/hs/LODD_Manual/Resources/IAFF%20Thermal%20Stress%20Protocol.pdf (last visited Feb. 16, 2019).

181. *Id.*

182. Michael F. Bergeron, *Youth Sports—Making It Safe in the Heat*, AM. C. SPORTS MED., https://www.acsm.org/docs/default-source/files-for-resource-library/smb-youth-sports---making-it-safe-in-the-heat.pdf?sfvrsn=8209b835_2 (last visited Dec. 28, 2018); INTER-ASSOCIATION TASK FORCE ON EXERTIONAL HEAT ILLNESSES CONSENSUS STATEMENT, NAT'L ATHLETIC TRAINERS' ASS'N, https://www.nata.org/sites/default/files/inter-association-task-force-exertional-heat-illness.pdf (last visited Dec. 28, 2018).

183. James Bruggers, *"This Was Preventable": Football Heat Deaths and the Rising Temperature*, INSIDECLIMATE NEWS (July 20, 2018), https://insideclimatenews.org/news/20072018/high-school-football-practice-heat-stroke-exhaustion-deaths-state-rankings-health-safety.

184. *Id.*

185. For a more complete list, *see* Ashley M. Gregor, *Toward a Legal Standard of Tolerable Heat*, COLUM. J. ENVTL. L. (forthcoming 2019).

186. Paula A. Franzese et. al., *The Implied Warranty of Habitability Lives: Making Real the Promise of Landlord-Tenant Reform*, 69 RUTGERS U. L. REV. 1, 11 (2016).

187. *Id.*

188. Stephane Rabiner, *Do Landlords Have to Provide Air Conditioning?*, L. & DAILY LIFE, (May 31, 2011), https://blogs.findlaw.com/law_and_life/2011/05/do-landlords-have-to-provide-air-conditioning.html. For a state-by-state breakdown of habitability statutes, see *State Habitability & Law Reference Guide*, LANDLORD (2014), http://www.landlord.com/state-habitability-statutes-by-state.htm.

rental housing to have cooling that keeps the temperature no greater than 86°F.[189]

Air conditioning is generally not required in public housing. Sometimes the government will pay for the machines but rarely for the electricity.[190] In New York City, almost 90% of all households have air conditioning, but less than half of those in public housing.[191]

B. Soldiers

The Department of Defense has issued a Technical Bulletin on Heat Stress Control and Heat Casualty Management, including "Hot Weather Deployment Tips,"[192] addressing acclimatization and physical fitness; hydration and nutrition; work/rest cycles and the reduction of heat exposure; clothing, equipment, and supplies; first aid; and the "weak link rule," which calls for an assessment of the entire unit after the first heat casualty. The Navy has its own manual on heat.[193] All the service branches use a system of color-coded flags (green, yellow, red, and black) to communicate hazardous heat conditions and encourage the adjustment of work/rest cycles.[194] The military also has a smartphone app called the Soldier Water Estimation Tool (SWET) to show how much water people need to drink based on their activity level and attire and the air temperature, humidity, and cloud cover.[195]

The Department of Defense requires central air conditioning in family housing on military bases in locations (both in the United States and other countries) with specified levels of warm weather.[196]

---

189. PHOENIX CITY CODE § 39-5.B.1.b.

190. UTILITY ALLOWANCE GUIDEBOOK, U.S. DEP'T HOUSING & URBAN DEV. 14 (1998), https://www.hud.gov/sites/documents/DOC_10600.PDF.

191. Sarah Gonzalez, *Without AC, Public Housing Residents Swelter Through the Summer*, WNYC NEWS (July 28, 2016), https://www.wnyc.org/story/life-new-york-public-housing-no-air-conditioning/.

192. DEP'T ARMY & AIR FORCE, HEAT STRESS CONTROL AND HEAT CASUALTY MANAGEMENT (2003), http://www.usariem.army.mil/assets/docs/partnering/tbmed507.pdf.

193. DEP'T OF THE NAVY, BUREAU MED. & SURGERY, MANUAL OF NAVAL PREVENTIVE MEDICINE, CHAPTER 3: PREVENTION OF HEAT AND COLD STRESS INJURIES (ASHORE, AFLOAT, AND GROUND FORCES) 3–14 (2009), http://www.med.navy.mil/directives/Pub/5010-3.pdf.

194. *Id.*

195. Kelly Field, *Army Develops App to Determine Body's Water Needs*, U.S. ARMY (Oct. 24, 2014), https://www.army.mil/article/136391/army_develops_app_to_determine_bodys_water_needs.

196. U.S. ARMY CORPS OF ENG'RS, UNIFIED FACILITIES CRITERIA (UFC): FAMILY HOUSING 24–25 (2006), https://www.wbdg.org/FFC/DOD/UFC/ufc_4_711_01_2006.pdf; ARMY FAMILY HOUSING PLANNING GUIDE, HOME INNOVATION RES. LABS 88 (2014), https://www.homeinnovation.com/~/media/Files/Reports/Army-Family-Housing-Planning-Guide.pdf.

C. Hazmat Cleanup Workers

Federal agencies have produced the very detailed Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities,[197] which is especially important for workers who clean up toxic sites in moon suits, perhaps the world's warmest garment. After the Deepwater Horizon oil spill in April 2010, BP instructed its cleanup crews to follow the work/rest regime that the military used to protect U.S. soldiers from heat stress in Iraq.[198] More than 40,000 workers wearing chemical-resistant suits, hard hats, impermeable gloves, and boots cleaned up the oil on the sunny shores in Louisiana, Mississippi, Texas, Alabama, and Florida.[199] They were given ample time to rest in the shade and drink water. Not a single worker was killed by the heat.[200]

D. Nursing Homes

Twelve residents of a nursing home in Hollywood, Florida, died from the heat when Hurricane Irma knocked out the power and the staff did not quickly move the elders in their care to safety.[201] The local police department has been investigating the incident as a homicide.[202] Nationwide, inspections find frequent violations of emergency planning rules (including operable backup generators) at nursing homes, but few result in stiff penalties being issued.[203] Nursing homes must be licensed by the state and follow state regulations, and many also seek federal certification for Medicare and Medicaid reimbursement.[204] Federal regulations require

197. U.S. DEP'T OF HEALTH & HUMAN SERVS., OCCUPATIONAL SAFETY AND HEALTH GUIDANCE MANUAL FOR HAZARDOUS WASTE SITE ACTIVITIES, (1985), https://www.osha.gov/Publications/complinks/OSHG-HazWaste/all-in-one.pdf; *see also* 29 C.F.R. § 1910.120(b)(4)(ii) (2018).

198. David Arkush & David Michaels, *Climate change isn't just cooking the planet. It's cooking our workforce.*, WASH. POST (July 19, 2018), https://www.washingtonpost.com/opinions/climate-change-isnt-just-cooking-the-planet-its-cooking-our-workforce/2018/07/19/15dd33e0-89fd-11e8-85ae-511bc1146b0b_story.html?utm_term=.d26e8cdf5251.

199. *Id.*

200. *Id.*

201. Nicholas Nehamas et al., *Hollywood nursing home where a dozen elders died 'made it worse,' state expert testifies*, MIAMI HERALD (Mar. 22, 2018), https://www.miamiherald.com/news/weather/hurricane/article206495659.html.

202. *Id.*

203. Jordan Rau, *Many Nursing Homes Aren't Prepared For Even Basic Emergencies*, NAT'L PUB. RADIO (Sept. 19, 2017), https://www.npr.org/sections/health-shots/2017/09/19/552042095/many-nursing-homes-arent-prepared-for-even-basic-emergencies.

204. *Nursing Homes*, CTRS. FOR MEDICARE & MEDICAID SERV., https://www.cms.gov/medicare/provider-enrollment-and-certification/ certificationandcomplianc/nhs.html (last visited Jan. 28, 2019).

nursing homes to have "comfortable and safe temperature levels"[205] and backup power to maintain "temperatures to protect resident health and safety,"[206] and many states have similar requirements.[207]

E. Schools

Air conditioning is generally not required in schools, and most are closed all summer. The federal Individuals with Disabilities Education Act (IDEA)[208] requires school districts to make reasonable accommodations for disabled students.[209] Many children with special needs are sensitive to the heat, and the Individual Education Programs given to these children sometimes require air conditioning in classrooms and school buses.[210] A New York City regulation requires buses for disabled students to have air conditioning.[211]

F. Prisoners

Prisoners are the one category of persons who enjoy (if that's the word) a constitutional right to some cooling. [212] More than 2.3 million inmates are incarcerated in a combined 1,800 federal and state prisons and 3,100 local jails across the United States[213] Nearly half a million correctional employees

---

205. 42 C.F.R. § 483.10(i)(6) (2018).

206. 42 C.F.R. § 483.73(b)(1)(ii)(A) (2018).

207. SARA HOVERTER, CLIMATE CHANGE, PUBLIC HEALTH, AND THE LAW 180 (Michael Burger & Justin Gundlach eds.) (forthcoming 2019). Further evidence of the vulnerability of nursing homes came during Hurricane Katrina, when thirty-five mostly bedridden patients in one drowned; the owners were acquitted of negligent homicide. Adam Nossiter, *Nursing Home Owners Acquitted in Deaths*, N.Y. TIMES (Sept. 8, 2007), https://www.nytimes.com /2007/09/08/us/nationalspecial/08nursing.html.

208. 20 U.S.C. § 1400 et seq. (2018).

209. 20 U.S.C. § 1400(d) (2018).

210. BETSY GOTBAUM ET. AL., LEFT IN THE DARK: CITYWIDE COUNCIL ON SPECIAL EDUCATION SURVEY FINDS DOE NOT INFORMING PARENTS OF EDUCATIONAL OPPORTUNITIES FOR CHILDREN WITH DISABILITIES 3, n.7, N.Y.C. (2007), http://www.nyc.gov/html/records /pdf/govpub/moved/pubadvocate/CCSEREPORTFINALWEB.pdf; *Warmer Months Turn Focus to School Bus Cooling Systems*, SCH. TRANSP. NEWS (Mar. 10, 2017), http://stnonline.com/news/latest-news/item/8419-warmer-months-turns-focus-to-cooling-systems.

211. N.Y.C. ADMIN. CODE § 19-605 (2018); *see also* James v. City of New York, 39 N.Y.S.3d 882, 883–84 (Sup. Ct. New York County Ct. 2016), *rev'd*, 154 A.D.3d 424 (N.Y. Sup. Ct. App. Div. 2017).

212. Daniel E.W. Holt, Sabin Ctr. for Climate Change Law, *Heat in U.S. Prisons and Jails: Corrections and the Challenge of Climate Change*, (2015), https://web.law.columbia .edu/sites/default/files/microsites/climate-change/holt_-_heat_in_us_prisons_and_jails.pdf.

213. *Id.* at i, 10.

work there, so in all, nearly 2.8 million people endure prison conditions.[214] If they were all together, they would be about tied with Chicago as the third largest city in the country.[215]

Many prisons are overcrowded, and inmates often have serious physical and mental health problems.[216] One in ten is aged fifty-five or older.[217] In 1991, the Supreme Court recognized warmth as an essential human need and observed that "a low cell temperature at night combined with a failure to issue blankets" could amount to a violation of the Eighth Amendment prohibition against cruel and unusual punishment.[218] Since then, numerous federal courts have applied the same logic to excessive heat, finding potential violations of the Eighth Amendment as well as of the Americans With Disabilities Act of 1990 and the Rehabilitation Act of 1973.[219]

Texas prisons have received particular attention. More than twenty state prisoners died from the heat between 1998 and 2017.[220] Just twenty-nine of 104 Texas prisons have air-conditioned units.[221] In 2017, a federal judge found that state officials had been "deliberately indifferent" to the heat in a prison for elderly inmates,[222] and in 2018, he approved a settlement under which air conditioning will be provided.[223]

Regardless of what the Constitution says, prisoners were subjected to appalling conditions (though not necessarily heat) and all but neglected

---

214. *Id.* at i.

215. Elvia Malagon, *Chicago's population down third year in a row – but we're still ahead of Houston: census*, CHI. TRIB. (May 24, 2018), https://www.chicagotribune.com/news/ct-met-chicago-population-census-figures-20180523-story.html.

216. Holt, *supra* note 212 at ii.

217. *Id.* at 19.

218. Wilson v. Seiter, 501 U.S. 294, 304 (1991).

219. *E.g.*, Walker v. Schult, 717 F.3d 119, 128 (2d Cir. 2013); Blackmon v. Garza, 484 F. App'x 866, 870–72 (5th Cir. 2012); Hathaway v. Holder, 491 F. App'x 207, 208 (2d Cir. 2012); Graves v. Arpaio, 623 F.3d 1043, 1049 (9th Cir. 2010); Vasquez v. Frank, 209 F. App'x 538, 541 (7th Cir. 2006); Hearns v. Terhune, 413 F.3d 1036, 1043 (9th Cir. 2005); Chandler v. Crosby, 379 F.3d 1278, 1294 (11th Cir. 2004); Gates v. Cook, 376 F.3d 323, 340 (5th Cir. 2004).

220. Maurice Chammah et al., *"Cooking Them to Death": The Lethal Toll of Hot Prisons*, MARSHALL PROJECT (Oct. 11, 2017), https://www.themarshallproject.org/2017/10/11/ cooking-them-to-death-the-lethal-toll-of-hot-prisons.

221. Gabrielle Banks & Keri Blakinger, *Heat Wave Sparks Concerns in Sweltering Texas Prisons*, HOUS. CHRON., https://www.chron.com/news/houston-texas/houston/article/Heat-wave-sparks-concerns-in-sweltering-Texas-13089898.php (last updated July 22, 2018, 6:39 PM).

222. Cole v. Collier, No. 4:14-CV-1698, 2017 U.S. Dist. LEXIS 112095, at *154 (S.D. Tex. July 19, 2017).

223. Gabrielle Banks, *Judge Approves Deal to Air Condition Texas Geriatric Prison*, HOUS. CHRON. (May 8, 2018, 10:05 AM), https://www.houstonchronicle.com/news/houston-texas/houston/article/Federal-judge-approves-historic-deal-proving-air-12898841.php.

during Hurricanes Rita (2005), Katrina (2005), Ike (2008), and the 2017 trio—Harvey, Irma and Maria.[224]

VII. LEGAL RECOMMENDATIONS

The law can do much to reduce greenhouse gas emissions, but that is beyond the scope of this article.[225] However, so much heat is baked into the system (especially the oceans), and so many emissions will continue around the world regardless of any imaginable regulations and technologies, that the earth will continue to warm for at least several more decades.[226]But meanwhile, there is much the law can do to help people and communities cope with heat.

State legislatures should expand the warranty of habitability to require landlords to provide tenants with protection against heat as well as cold. Low-income energy assistance programs should be fully funded and should cover both the purchase of air conditioners and the electricity to run them (as they now help pay for heating oil and gas). As is now the case with military family housing, public housing in all but the coolest areas should have air conditioning. Because this action could make the housing less affordable, the government will need to step up its funding to fill the need. Building codes should encourage ventilation, awnings, shades, and other traditional methods to lower the heat.

Governments at all levels should buy only the most efficient air conditioners to help drive the market. The federal government should progressively tighten the efficiency standards for air conditioning to help drive the technology.

To lower the urban heat island effect and reduce energy demand, states and cities should require cool roofs, green roofs, or solar panels for new buildings and reconstructed roofs where the geometry of the architecture allows it. Incentives such as tax credits should be provided to help owners retrofit existing buildings. Paved surfaces should be minimized, and where they are necessary, created with light-colored and preferably porous pavement. Cities should plant large numbers of trees on public property, and

---

224. William Omorogieva, Sabin Ctr. for Climate Change Law, *Prison Preparedness and Legal Obligations to Protect Prisoners During Natural Disasters*, 32, 37 (2018), http://columbiaclimatelaw.com/files/2018/05/Omorogieva-2018-05-Prison-Preparedness-and-Legal-Obligations.pdf; Ira P. Robbin, *Lessons from Hurricane Katrina: Prison Emergency Preparedness as a Constitutional Imperative*, 42 U. MICH. J. L. REFORM 1, 2–4 (2008).

225. For a detailed discussion of legal options, *see* LEGAL PATHWAYS TO DEEP DECARBONIZATION IN THE UNITED STATES, (Michael B. Gerrard & John Dernbach eds., forthcoming 2019).

226. RAJENDRA K. PACHAURI ET AL., CLIMATE CHANGE 2014 SYNTHESIS REPORT, INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE 10 (2015), https://www.ipcc.ch/pdf/assessment-report/ar5/syr/AR5_SYR_FINAL_SPM.pdf.

maintain them well, ideally with community assistance. Cities should also require private developments to preserve as many trees as possible, and to have extensive landscaping and vegetation, both horizontal and vertical.

Social service agencies should encourage programs to check in on vulnerable people (especially the elderly and disabled living alone) during heat waves. Heat warnings and tips should be widely announced through broadcast and social media. All-night cooling centers should be established, and their locations well-publicized. Nursing homes and assisted living facilities should be frequently checked during heat waves.

Air conditioning should be provided in the hottest prisons, jails, and other detention facilities, and at least passive cooling in the rest. Where it is still hot, inmates should be given ample cool water and allowed to take frequent showers. Contracts with private facilities should require the same precautions. The size of the incarcerated population should also be reduced, but that is straying into other areas of law.

In the occupational setting, OSHA should establish formal binding standards for heat exposure and relief, not just guidelines, and it should conduct frequent inspections to ensure compliance. For outdoor workers, precautions similar to those adopted by the United States Armed Forces and California should be required.

If all of this is done, people and communities will be much better able to cope with the extreme temperatures that are in our future.