# ARTICLES

# PREVENTING WIND WASTE

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*The United States has vast offshore wind resources—nearly double the total electricity consumption of the country—ideally located close to the largest population centers. This abundance has remained stubbornly untapped for over a decade, without a single commercial scale wind project built in federal waters as of early 2021.*

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*In contrast to obstruction by the Trump administration, President Biden, in his first days in office, singled out offshore wind development as one of his priorities for tackling the climate crisis. As a result, the United States may soon see an offshore wind rush.*

*Onshore, the United States is a world leader in wind energy, but that development has come at the price of heavy waste of the resource. A common law rule of capture, like the one applied in the early days of oil and gas development, has fostered competitive and protectionist practices. Individual wind developers have an incentive to maximize energy recovery within their own wind farms, but they have no incentive to maximize recovery of the entire resource.*

*There is even more reason than in the oil and gas context to maximize recovery of the entire U.S. offshore wind resource. While maximizing an oil and gas field simply contributes more greenhouse-gas-producing product, maximizing carbon-free energy production benefits the U.S. public, as well as the world, by helping mitigate climate change. Furthermore, offshore wind in federal waters is an asset collectively owned by all U.S. citizens; maximizing production can generate maximum payments to the public.*

*As with oil and gas development, regulation is required to prevent waste and force consideration of the correlative rights of other developers in a common pool. Uniformity of ownership by the federal government should facilitate consistent, cooperative wind development, which is something that is not possible on land because of the competing priorities of different owners. Lessons learned from common law waste and state oil and gas waste statutes, as well as the federal regulations on the topic, can inform the promulgation of regulations that will best facilitate the development of offshore wind. In this regard, two criteria should guide offshore wind development—maximizing the quantity of recoverable resource and avoiding the construction of unnecessary infrastructure to harvest it.*

*This Article is the first to address the unique qualities of wind energy development and comprehensively combine the science with the law. The federal statute that regulates offshore oil and gas waste is the very vehicle Congress chose for offshore wind energy development. Consequently, this Article provides a foundation, first, by exploring the history of waste law in general and then waste in the context of oil and gas. A thoughtful application of the lessons learned in those contexts can help transform this federal offshore wind rush into a model for efficient and climate-friendly wind development worldwide.*

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## INTRODUCTION

In 2020, the United States ranked second in the world for installed wind power capacity.[1] Additionally, wind power outranked all other

1. *Worldwide Wind Capacity Reaches 744 Gigawatts—An Unprecedented 93 Gigawatts Added in 2020*, WORLD WIND ENERGY ASS'N (Mar. 24, 2021), https://wwindea.org/worldwide-wind-capacity [https://perma.cc/Y95W-M543]. The countries with the

U.S. renewable energy resources, both in terms of installed capacity and the amount of electricity produced.[2] U.S. offshore resources are vast, with a current actual potential of nearly double the total electricity consumption of the United States.[3] Yet, with the exception of two small pilot projects, one in state and one in federal waters, all U.S. wind energy production has been onshore or "terrestrial wind."[4]

In contrast to the Trump administration's obstruction of offshore wind development through restrictions and delayed approvals,[5]

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greatest total installed wind power capacity are China (290,000 megawatts), United States (122,328 megawatts), and Germany (62,784 megawatts). *Id.*

2. *Frequently Asked Questions (FAQs): What Is U.S. Electricity Generation by Energy Source?*, U.S. ENERGY INFO. ADMIN. (Mar. 5, 2021), https://www.eia.gov/tools/faqs [https://perma.cc/58M8-ZJFE]. In 2021, wind power accounted for 8.4% (338 billion kWh) of all utility-scale electricity generation; hydropower accounted for 7.3% (291 billion kWh); solar accounted for 2.3% (91 billion kWh); and biomass accounted for 1.4% (56 billion kWh). *Id.*

3. *Computing America's Offshore Wind Energy Potential*, OFF. OF ENERGY EFFICIENCY & RENEWABLE ENERGY, DEP'T OF ENERGY (Sept. 9, 2016), https://www.energy.gov/eere/articles/computing-america-s-offshore-wind-energy-potential [https://perma.cc/3XC3-W8RN]. Gross potential is more than five times higher but limited by current turbine technologies. *Id.*

4. In May of 1953, Congress passed the Submerged Lands Act, Pub. L. No. 83-31, 67 Stat. 29 (1953), which granted individual states rights to the natural resources of submerged lands from the coastline to approximately three nautical miles seaward. *Id.* §§ 2(a), 3(a). Using its authority under the Submerged Lands Act, Rhode Island issued a state lease for state-controlled Submerged Land Act areas off Block Island. The Block Island Wind Farm, which came online in December 2016, was the first U.S. offshore wind development. Robin Kundis Craig, *It's Not Just an Offshore Wind Farm: Combining Multiple Uses and Multiple Values on the Outer Continental Shelf*, 39 PUB. LAND & RES. L. REV. 59, 71 (2018). Although some would not characterize it as a pilot because it provides power to the island, the Block Island Wind Farm is small, involving only five six-megawatt turbines or a total of thirty megawatts of capacity. *Id.* Dominion Energy's Coastal Virginia Offshore Wind Project (CVOW) is comprised of two six-megawatt turbines, or a total capacity of only twelve megawatts. *Coastal Virginia Offshore Wind Project (CVOW)*, BUREAU OF OCEAN ENERGY MGMT., U.S. DEP'T OF THE INTERIOR, https://www.boem.gov/renewable-energy/state-activities/coastal-virginia-offshore-wind-project-cvow [https://perma.cc/R3JB-758V]. The CVOW is located twenty-seven miles off the coast of Virginia Beach. *Id.*

5. *See, e.g.*, *Trump's Ban on Offshore Oil Drilling in Southern States Also Restricts Offshore Wind*, INST. FOR ENERGY RSCH., (Oct. 13, 2020), https://www.instituteforenergyresearch.org/fossil-fuels/gas-and-oil/trumps-ban-on-offshore-oil-drilling-in-southern-states [https://perma.cc/FU3H-LR83] (cataloging President Trump's executive orders banning new leasing along the coasts of Florida, Georgia, and the Carolinas for conventional and renewable energy development); Karl-Erik Stromsta, *Trump Administration 'Slow-Walking' Offshore Wind Permits: Sen. Whitehouse*, GREENTECH MEDIA (Sept. 29, 2020), https://www.greentechmedia.com/articles/read/trump-

President Biden, on one of his first days in office, singled out offshore wind development as one of his priorities for tackling the climate crisis.[6] Consequently, the United States may soon see an offshore wind rush. There are over 28,000 megawatts of wind capacity proposed for offshore development, and agreements to purchase offshore wind generation tripled within one year.[7]

The "transformed" U.S. perspective of property development and waste will likely inform the development of wind energy off our coasts because the federal statute regulating offshore wind development in the United States permits, and sometimes mandates, changing a property to maximize its value. The American "transformed" concept of waste stands in stark contrast to the traditional English law that prohibited any change. In addition, the federal offshore wind statute recognizes the "prevention of waste" and the "protection of correlative rights" as factors that the Secretary of Energy must consider when approving offshore wind development in federal waters.[8] As these concepts, and the statute itself, arose from oil and gas law, that body of law can provide precedent for how to treat wind energy development.

First, this Article will start with an analysis of waste's roots in English law and early U.S. common law. Second, it will address waste specifically in the context of state and federal oil and gas law, as well as

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administration-slow-walking-offshore-wind-permits-sen-whitehouse [https://perma.cc/9FYD-3UDB] (contending that federal holdups are delaying wind energy development).

6. Exec. Order No. 14,008, 86 Fed. Reg. 7,619 (Jan. 27, 2021) (announcing that the order was passed "with the goal of doubling offshore wind by 2030").

7. *2019 Wind Energy Data & Technology Trends*, OFF. OF ENERGY EFFICIENCY & RENEWABLE ENERGY, DEP'T OF ENERGY, https://www.energy.gov/eere/wind/2019-wind-energy-data-technology-trends [https://perma.cc/S46Q-UWKE] (U.S. offshore wind energy capacity has grown extensively since 2018, and offshore wind capacity with a signed offtake agreement, guaranteeing its purchase from an energy buyer, tripled between 2019 and 2020). An offtake agreement is a contract between a wind company and an entity that needs the electricity formalizing the buyer's intent to purchase all or a set amount of the producer's future output. *What Is Offtake Agreement?*, L. DICTIONARY, https://thelawdictionary.org/offtake-agreement [https://perma.cc/7A7C-PKF2].

8. Energy Policy Act of 2005, 43 U.S.C. § 1337(p)(4)(C), (G) ("The Secretary shall ensure that any activity under this subsection is carried out in a manner that provides for . . . *prevention of waste* . . . [and] *protection of correlative rights in the outer Continental Shelf* . . . ." (emphasis added)). This language arose in the context of oil and gas leasing, where the concept of waste has a long history. This Article will address the meaning of "prevention of waste" and "protection of correlative rights" in the context of offshore wind energy development.

how waste relates to the doctrine of correlative rights. Third, it will consider wind energy development and how waste and correlative rights concepts apply to wind waking in U.S. offshore wind development.[9] Finally, it will provide proposed regulatory approaches to prevent waste of this valuable climate-friendly public resource.[10]

## I. WASTE LAW

Although U.S. law on waste evolved from English law, the doctrine took a dramatic turn from protecting preexisting uses of properties to encouraging uses that developed properties to ameliorate or make them better. This Part begins with the historical background of waste in England and then explains how the traditional English doctrine transformed in U.S. law and how it relates to correlative rights.

### *A. Historical Background*

Waste law, which originated as a term of property law, punishes a tenant for changes to an estate that detrimentally impact an inheritance.[11] In a comprehensive analysis of early waste law, *Rogers v. Atlantic G. & P. Co.*[12] defined waste as "[s]poil or destruction done or permitted to lands, houses, or other corporeal hereditaments, by the tenant thereof, to the prejudice of the heir or of him in reversion or remainder."[13] To understand the modern interpretations of waste law and approach a current definition, it is necessary to explore and understand the history of how scholars and courts have defined and applied waste law.

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9. Wind turbines affect the air downwind of the blades after the wind has gone through the turbine, creating wakes like boat wakes in water.

10. This Article focuses on wind waste within offshore areas that Bureau of Ocean Energy Management (BOEM) has decided to lease. Another issue, beyond the scope here, is the "upstream" decision, solely in the hands of the federal government, to decide how much ocean to lease to private developers and whether the wind resource is wasted if it is not even leased in the first place. Arguably, it is wasteful to only lease a tiny fraction of that technical capacity, especially where the demand is there and the need to decarbonize is so acute. It is a somewhat different conceptualization of waste as compared to that of oil and gas, but it is a worthwhile conversation when (1) the cost of not exploiting the resource is so severe due to the climate crisis, and (2) the pressures to not lease an area due to user conflicts and viewshed concerns are so great.

11. RICHARD R. POWELL, POWELL ON REAL PROPERTY § 56.01 (Michael Allan Wolf Desk ed., 2021).

12. 107 N.E. 661 (N.Y. 1915).

13. *Id.* at 661.

Waste law can be traced back to before the thirteenth century in early English statutes that contain some of the first references to waste as a legal term of art.[14] The feudal system of governance defined possession rights, which recognized that different persons could have separate and distinct interests in the same parcel of land.[15] The concept of waste arose out of the necessity for settling disputes between differing interests.[16] Within the waste concept, Lord Coke interpreted two English statutes to differentiate between "tenancies for years and for life."[17]

During the nineteenth century, English law expanded on the concept of waste through a series of essays, treatises, and cases. The common law recognized waste in three forms: (1) diminishing the estate's value, (2) increasing the burden upon the estate, or (3) impairing the title's evidence.[18] The strict enforcement of waste law continued, and tenants or life estate owners were held responsible for "virtually all changes to the landscape."[19] The doctrine of waste at the time prohibited "converting ancient meadow into arable, or arable or pasture into wood."[20] Therefore, any type of change to an existing property or landscape could create waste.[21]

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14. POWELL, *supra* note 11, § 56.02.

15. Morton Gitelman, *The Impact of the Statute of Gloucester on the Development of the American Law of Waste*, 39 ARK. L. REV. 669, 670 (1986).

16. *See id.* at 671–72 (arguing that "[a] remedy for waste which would provide damages and amercement [fines] might help prevent injury to land or buildings by tenants in possession" in lieu of self-help remedies).

17. *See Rogers*, 107 N.E. at 661 (discussing Lord Coke's conclusion that the two statutes applied to permissive waste but noting that "English cases at least raise a doubt on the point, and there seems to be a distinction between tenancies for years and for life").

18. Jill M. Fraley, *A New History of Waste Law: How a Misunderstood Doctrine Shaped Ideas About the Transformation of Law*, 100 MARQ. L. REV. 861, 869 (2017) (quoting GEORGE V. YOOL, AN ESSAY ON WASTE, NUISANCE, AND TRESPASS CHIEFLY WITH REFERENCE TO REMEDIES IN EQUITY: TREATING OF THE LAW OF TIMBER, MINES, LIGHTS, WATER, SUPPORT, THE CONSTRUCTION OF PUBLIC WORKS, &C., &C. 2 (London, W. Maxwell 1863)).

19. *Id.* at 869.

20. Greene v. Cole (1669) 85 Eng. Rep. 1022, 1029 n.5(b).

21. *See* Fraley, *supra* note 18, at 877 (explaining that early property boundaries used descriptive terms to map, so specific landmarks had to be left intact to preserve the property boundaries). Waste law could be applied whenever a tenant made a change to a property that would make it more challenging to identify the boundaries of a property, protecting any possibility of "injury to title." *Id.* at 882–84. Many laws at this time in England were reliant on early methods of surveying the property, and waste law could be used to protect the evidence of the boundaries of a specific property

### *B. The American Transformation*

While many English laws immediately took hold in American legal practice, the treatment of waste began to change, leading to the "transformation" of waste law.[22] U.S. state courts typically held that waste law required some kind of permanent injury or material prejudice to the inheritance or property in question.[23] Somewhere in the mid-to-late 1800s, U.S. law shifted from a strict application of the

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according to the surveillance techniques available. *Id.* at 879–82. For an example of a U.S. case based on the same waste principles, see Melms v. Pabst Brewing Co., 79 N.W. 738, 738–39 (Wis. 1899) ("It has been frequently said that this injury may consist either in diminishing the value of the inheritance, or increasing its burdens, or in destroying the identity of the property, or impairing the evidence of title. The last element of injury so enumerated, while a cogent and persuasive one in former times, has lost most, if not all, of its force at the present time. It was important when titles were not registered, and descriptions of land were frequently dependent upon natural monuments, or the uses to which the land was put . . . .").

22. *See generally* MORTON J. HORWITZ, THE TRANSFORMATION OF AMERICAN LAW, 1780–1860, at 30 (1977) (stating that "[b]y 1820 the legal landscape in America bore only the faintest resemblance to what existed forty years earlier," signaling a drastic transformation from English law); Jedediah Purdy, *The American Transformation of Waste Doctrine: A Pluralist Interpretation*, 91 CORNELL L. REV. 653 (2006) (providing a thorough discussion of multiple explanations of economic theories of the transformation of the law of waste in the United States and concluding that the transformation stems from a pluralist account while economic theories guide doctrinal interpretation). Some scholars have rejected the notion that a "transformation" of waste law has occurred in the United States, instead suggesting that by tracing the history of waste law, its current treatment aligns with the English common law. *See, e.g.*, Fraley, *supra* note 18, at 920–21 (explaining how "[w]aste law has been transformational well beyond its bounds").

23. *See, e.g.*, Pynchon v. Stearns, 52 Mass. (11 Met.) 304, 312 (Mass. 1846) (stating that "it is difficult to imagine any exception to the general rule of law, that no act of a tenant will amount to waste, unless it is or may be prejudicial to the inheritance, or to those entitled to the reversion or remainder"). *Pynchon* was probably the turning point in how American courts applied waste laws because the practices of farmers in the new American wilderness were different from the way English farmers worked their established lands. Fraley, *supra* note 18, at 893–94. Given that the ways in which farmers changed their use of land did not effectively change the title to lands, the strict application of English waste laws seemed inappropriate and inefficient. *Id.* Shortly after *Pynchon* was decided, the Supreme Court of Rhode Island held, on similar grounds to the *Pynchon* court, that they were "not to apply the English law too strictly" because "[o]ur lands are in many respects cultivated differently from land in England" Clemence v. Steere, 1 R.I. 272, 274 (1850). Then, in 1881, the Mississippi Supreme Court held that the English waste law "test" did not apply because "[t]he condition of this country and that of England are wholly dissimilar." Cannon v. Barry, 59 Miss. 289, 303 (1881).

original English law to a more contextual application, given novel American land-use situations.[24]

The oil booms of the early twentieth century drove legislatures and the judiciary to act to prevent "negligent, opportunistic, or larcenous acts of a tenant who lacked incentive to maximize presently discounted long-term returns from the estate, and so took actions inconsistent with the interest of the reversioner."[25] In *Tiffany's Treatise(s) on Real Property*, the change from English law was noted, stating that

> [i]n former times, some acts were regarded as waste merely because they changed the appearance of the land, and so impaired the evidence of title thereto, but with the adoption of improved methods of identifying land, this can no longer be regarded as waste.[26]

U.S. courts experienced a trend toward restricting the application of the English law of waste to adapt it to the growth conditions of the United States and stimulate the development of the land.[27]

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24. Fraley, *supra* note 18, at 896–98.

25. Purdy, *supra* note 22, at 675; *see, e.g.*, Rogers v. Atl., G. & P. Co., 107 N.E. 661, 661 (1915) (defining waste as "[s]poil or destruction done or permitted to lands, houses, or other corporeal hereditaments, by the tenant thereof, to the prejudice of the heir or of him in reversion or remainder"). The court in *Rogers* also introduced two forms of waste: permissive and voluntary. *Id.* Permissive or negligent waste is "the mere neglect or omission to do what will prevent injury" and can occur in such situations as when a house is not maintained and, therefore, falls into a state of disrepair. *Id.* Voluntary or actual waste occurs "in the commission of some destructive act," such as cutting down timber or destroying a house. *Id.*

26. 1 HERBERT THORNDIKE TIFFANY, THE LAW OF REAL PROPERTY AND OTHER INTERESTS IN LAND 560 (1903) (explaining that land was once defined by surveyable physical attributes, but given modern surveying techniques, such definitions may not be necessary).

27. *See, e.g.*, Dixon v. Pugh, 178 P. 880, 881–82 (Okla. 1918) ("The modern rule that governs in this class of cases is stated by Tiffany in his work on the Modern Law of Real Property: 'The question of what constitutes waste is, at the present day, determined primarily, at least, by the consideration whether the act results in injury to the inheritance. In former times, some cases are regarded as waste merely because they changed the appearance of the land, and so impaired the evidence of title thereto; but, with the adoption of improved methods of identifying lands, this can no longer be regarded as waste. It was, in part at least, on this principle, that any change in the character of the land, as of meadow into ar[a]ble land, or arable land into wood, was formerly regarded as constituting waste, but at the present day such a change would not be waste, at least in this country, unless it constitute an actual injury to the inheritance. A merely trifling damage has from early times been regarded as insufficient to support an action for waste; the judgment being entered for defendant in case the jury finds for the plaintiff in merely nominal damages. In determining whether particular acts constitute waste, the condition and usages of the particular locality are to be considered; a thing thus constituting waste in one locality which is

In English law, waste law punished any change to the property, even if the change increased the value of the property in question.[28] A strict application of the English laws of waste would not have fostered the rapid development of land in the United States, a situation that was unnecessary in England at the time the waste laws were developed there.[29] Industrial growth in the United States also may have contributed to a more permissive application of waste law, and U.S. courts seemed to accommodate greater changes in property than they previously would have allowed to encourage rapid property development.[30]

The established rules on waste began to give way to this new American doctrine in the late nineteenth century. In the case of *Melms v. Pabst Brewing Co.*,[31] viewed as "the leading American case" on ameliorative waste,[32] U.S. courts departed further from English law, where any waste was strictly prohibited.[33] In *Melms*, the defendant owner of a life estate razed a residence that had become surrounded by factories and railroad tracks. The remaindermen—those who were to receive the property after the life estate—sued for waste. The *Melms* court held that there was indeed waste because "any change in a building upon the premises . . . may constitute technical waste," and

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not waste in another. The general tendency of the American courts has been to restrict the application of the English law of waste, in order to adapt it to the condition of a new and growing country, and to stimulate the development of the land by the tenant in possession.'").

28. RALEIGH COLSTON MINOR & JOHN WURTS, THE LAW OF REAL PROPERTY (BASED ON MINOR'S INSTITUTES) § 381 (1909). *See generally* John A. Lovett, *Doctrines of Waste in a Landscape of Waste*, 72 MO. L. REV. 1209 (2007) (exploring the multiple perspectives on waste law through a description of a multitude of doctrines of waste, stating that "virtually every property law hornbook or case book will offer some treatment of waste," and highlighting the importance of waste a midst legal and political changes).

29. *See Dixon*, 178 P. at 881–82 (noting that American courts adapted the strict English law of waste to the growing American economy, which was driven by the exploitation of natural resources).

30. *Id.*

31. 79 N.W. 738 (Wis. 1899).

32. DALE A. WHITMAN ET AL., THE LAW OF PROPERTY § 4.2 (4th ed. 2019); *see* Thomas W. Merrill, Melms v. Pabst Brewing Co. *and the Doctrine of Waste in American Property Law*, 94 MARQ. L. REV. 1055, 1055 (2011) ("Melms v. Pabst Brewing Co. may be the most important decision ever rendered by an American court concerning the law of waste." (footnote omitted)).

33. *See* Merrill, *supra* note 32, at 1058 (noting that prior to *Melms*, "any material alteration of property by someone temporarily in possession was regarded as waste," but that after *Melms*, this old rule began to break down (emphasis omitted)).

the building here was permanently destroyed.[34] However, the court further held that this change would "not be enjoined in equity when it clearly appears that the change will be, in effect, ameliorating change, which rather improves the inheritance than injures it."[35] Therefore, as there was no express or implied obligation in the will to use the property for a specific purpose or maintain it in its current condition, Pabst was allowed to commit waste because—due to permanent changes in the surrounding area from residential to commercial—the waste would make the property valuable again.[36]

### *C. Types of Waste*

The modern interpretation of waste law in America became value-driven.[37] Explanations for the shifts and changes in waste law have been described as stemming from economic, social, and environmental factors.[38] For example, Harold Demsetz proposed that property rights generally have evolved according to the self-interest of economic actors.[39] Morton J. Horwitz relied on socioeconomics for the liberalization of English waste law, stating that "an economy dependent on clearing land for economic development could not

34. *Melms*, 79 N.W. at 739.

35. *Id.*

36. *Id.* at 741 ("[T]he landlord or reversioner . . . is [usually] entitled to receive the property . . . substantially in the condition in which it was when the tenant received it; but when, as here, there has occurred a complete and permanent change of surrounding conditions, which has deprived the property of its value and usefulness as previously used, the question whether a life tenant . . . has been guilty of waste is . . . a question of fact for the jury . . . .").

37. Types of waste include permissive, voluntary, and ameliorative waste. *See* MINOR & WURTS, *supra* note 28, §§ 380–89 ("Voluntary waste is the result of the tenant's acts of commission, as the unauthorized destruction of houses or cutting down of trees or digging of minerals; while permissive waste results from acts of omission or the negligence of the tenant, as by suffering a house to fall by the neglect of necessary repairs, or by the negligent breaking of doors, windows, etc., or, possibly, from the deliberate or negligent act of strangers or from pure accident.").

38. *See, e.g.*, John G. Sprankling, *The Antiwilderness Bias in American Property Law*, 63 U. CHI. L. REV. 519, 520–33 (1996) (focusing on the role of law in the destruction of wilderness land and arguing that an "antiwilderness bias still influences modern property law," resulting in the resolution of property disputes in favor of wilderness destruction).

39. Harold Demsetz, *Toward a Theory of Property Rights*, 57 AM. ECON. REV. 347, 350 (1967).

enforce a rule of maintaining the existing condition of land."[40] The following sections will explore physical waste in oil and gas extraction, as well as how similar economic, social, and environmental drivers have affected the development of new legal concepts relating to oil and gas waste.

In its early days, oil development was characterized by "profligate drilling and tremendous physical waste."[41] After "Colonel" Edwin Drake in Pennsylvania discovered that oil could be extracted by drilling, he "sparked a local oil boom that spread throughout Pennsylvania and into nearby states."[42] About forty years later, oil was discovered in Spindletop, Texas, and the number of wells exploded from thirteen to over four hundred in just eight months.[43] In both locations, the rapid expansion led to physical, economic, social, and environmental waste.[44] Physically, spilled oil pooled in unlined pits, causing leakage into ground water and evaporation into the air.[45]

With respect to economics, overproduction meant unstable prices: at one point, oil was selling for three cents per barrel while water was

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40. Morton J. Horwitz, The *Transformation in the Conception of Property in American Law, 1780–1860*, 40 U. CHI. L. REV. 248, 279 (1973); *see also* Purdy, *supra* note 22, at 696–98 (providing multiple explanations of economic theories of waste transformation in America, and concluding that the transformation stems from a pluralist account while economic theories guide doctrinal interpretation); Cities Serv. Gas Co. v. Peerless Oil & Gas Co., 340 U.S. 179, 187 (1950) (allowing an early examination of social influence of law which strayed from the strict legal reasoning analysis that existed previously).

41. Howard R. Williams, *Conservation of Oil and Gas*, 65 HARV. L. REV. 1155, 1159 (1952).

42. Ian McCabe, *Achieving U.S. Energy Autonomy: The Problems, Solutions and Side Effects of Weaning the American Economy off Foreign Oil*, 3 APPALACHIAN NAT. RES. L.J. 169, 170 (2009).

43. JUDITH WALKER LINSLEY ET AL., GIANT UNDER THE HILL: A HISTORY OF THE SPINDLETOP OIL DISCOVERY AT BEAUMONT, TEXAS IN 1901, 12 (2002).

44. *See* Jacqueline Lang Weaver, *The Tragedy of the Commons from Spindletop to Enron*, 24 J. LAND, RES., & ENV'T L., 187, 187–88 (2004) (documenting the rapid growth and rampant waste of early extraction); *see also* David E. Pierce, *Minimizing the Environmental Impact of Oil and Gas Development by Maximizing Production Conservation*, 85 N.D. L. REV. 759, 759 (2009) (discussing the transition "of rights in oil and gas reservoirs away from capture rights and toward correlative rights" with the result that "state oil and gas conservation commissions can [maximize] development of the oil and gas resource . . . while minimizing the impact on surface and other natural resources").

45. Weaver, *supra* note 44, at 187–88 (explaining how "[t]he waste in our oil fields in the first decades of the twentieth century was staggering. Torrents of oil ran down creeks and streams or were put in earthen storage subject to fire, evaporation, and floods").

selling for five cents per cup in the same towns.[46] Aside from the physical and economic waste, these booms had serious social and environmental impacts, upending communities and allowing the uncontrolled release of fluids and gases that burned or poisoned humans and animals.[47]

When the shift of focus on resource extraction broadens from simply the economic as between the correlative parties extracting a resource to also include broader societal and environmental factors, regulators can play a significant role.[48] Thus, state governments began to intervene to address the problem of waste in oil and gas development. Some of the first statutes prohibited actions that caused physical waste, such as allowing an oil well to ignite or to gush.[49] Others addressed economic waste by limiting production.[50] Eventually, pooling and well-spacing regulations were added to encourage maximum reservoir

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46. DANIEL YERGIN, THE PRIZE: THE EPIC QUEST FOR OIL, MONEY & POWER 70 (2008).

47. *See* Elliff v. Texon Drilling Co., 210 S.W.2d 558, 559, 563 (Tex. 1948) (discussing liability for gas blowout poisoning neighbor's cattle). *See also* LINSLEY ET AL., *supra* note 43, at 121, 126, 164–67.

48. *See* Cont'l Oil Co. v. Oil Conservation Comm'n, 373 P.2d 809, 818 (N.M. 1962) ("The prevention of waste is of paramount interest, and protection of correlative rights is interrelated and inseparable from it. The very definition of 'correlative rights' emphasizes the term 'without waste.' However, the protection of correlative rights is a necessary adjunct to the prevention of waste. *Waste will result unless the commission can also act to protect correlative rights.*" (emphasis added)); *see also* Cities Serv. Gas Co. v. Peerless Oil & Gas Co., 340 U.S. 179, 185 (1950) ("It is now undeniable that a state may adopt reasonable regulations to prevent economic and physical waste of natural gas."); Peter D. Junger, *The Wyoming Oil and Gas Conservation Act: Private Rights and Public Policy*, 13 WYO. L.J. 1, 5 (1958) ("The purpose of the Compact is to 'conserve oil and gas by the prevention of physical waste thereof from any cause.'"); Barton H. Thompson, Jr., *Resource Use and the Emerging Law of "Takings": A Realistic Appraisal*, 42 ROCKY MT. MIN. L. INST. 2, 2–22 (1996).

49. *See Legislation: Oil and Gas Conservation*, 43 HARV. L. REV. 1137, 1138–40 (1930) (detailing legislative efforts in Arkansas, Louisiana, and Oklahoma); Thomas A. Mitchell, *The Future of Oil and Gas Conservation Jurisprudence: Past as Prologue*, 49 WASHBURN L.J. 379, 414 (2010) (noting the creation of a Pennsylvania regulatory authority after the 1984 Oil and Gas Act); Phillip E. Norvell, *The History of Oil and Gas Conservation Legislation in Arkansas*, 68 ARK. L. REV. 349, 357–61, 370 (2015) (noting that Oklahoma and Texas were among the first states to pass market-demand proration statutes).

50. *See* Junger, *supra* note 48, at 5–6 (explaining that the Interstate Oil Compact Commission aimed to conserve gas by preventing physical waste); Norvell, *supra* note 49, at 365 (articulating that Arkansas attempted to "confront the problem of waste" by conserving oil and gas); ARK. CODE ANN. § 15-72-101 (2021) (attempting to eradicate the "evils" of oil and gas use by prohibiting waste and ratable production).

development.[51] Although mineral owners challenged many of these regulations as unconstitutional "takings," the U.S. Supreme Court upheld Ohio's regulations as a valid exercise of the state's police power, noting that the legislative power "can be manifested for the purpose of protecting all the collective owners, by securing a just distribution, to arise from the enjoyment by them, of their privilege to reduce to possession, and to reach the like end by preventing waste."[52]

By the 1930s, five states had created oil and gas conservation commissions or delegated responsibility to existing commissions to regulate oil and gas operations.[53] By the early 1950s, the majority of oil-producing states passed comprehensive conservation legislation,[54] many following the 1949 model legislation the Interstate Compact to Conserve Oil and Gas,[55] which focused on correlative rights and preventing waste.[56] Today, there is some form of oil and gas conservation regulation in every oil and gas producing state.[57]

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51. Spacing designates the number of wells over an oil and gas reservoir and the density which they can be drilled for conservation purposes. Pooling refers to the combination of small tracts among adjacent owners to conform to the spacing pattern in order to receive a permit. PATRICK H. MARTIN ET AL., MANUAL OF OIL AND GAS TERMS 727, 1072–73 (Fred D. Nation, Jr., et al. eds., 7th ed. 1987).

52. Ohio Oil Co. v. Indiana, 177 U.S. 190, 210 (1900); *see also* Knighton v. Texaco Producing, Inc., 762 F. Supp. 686, 689 (W.D. La. 1991), *aff'd*, 988 F.2d 1209 (5th Cir. 1993) ("If Louisiana had adopted the rule in an unmodified form, an owner could have drilled as many wells on his land as he cared to drill. To avoid actual or perceived drainage, however, his neighbor could have drilled as many retaliatory wells as he deemed necessary . . . . Society would not tolerate the unbridled lust for oil and gas to dissipate a natural resource. The property owner's unlimited right to explore had to be curtailed in the name of conservation. Thus, exercising its police power *to prevent waste*, the Louisiana Legislature passed conservation measures that were, and are, administered by the Department of Conservation, headed by a Commissioner of Conservation." (emphasis added)).

53. Robert E. Hardwicke, *The Rule of Capture and Its Implications as Applied to Oil and Gas*, 13 TEX. L. REV. 391, 419–20 (1935); *see* A.W. Walker, Jr., *Property Rights in Oil and Gas and Their Effect Upon Police Regulation of Production*, 16 TEX. L. REV. 370, 380–81 (1938); *see also* Kemp Wilson, *Conservation Acts and Correlative Rights: Has the Pendulum Swung Too Far?*, 35 ROCKY MTN. MIN. L. INST. 18-1, 18-2 (1989).

54. 6 EUGENE KUNTZ, A TREATISE ON THE LAW OF OIL AND GAS, PARTS 1 & 2 (2000).

55. Joint Resolution Consenting to an Interstate Oil Compact to Conserve Oil and Gas, H.R.J. Res. 407, 74th Cong. 49 Stat. 939, 940 (1935).

56. *Id.*; Blakely M. Murphy, *The Administrative Mechanism of the Interstate Compact to Conserve Oil and Gas: The Interstate Oil Compact Commission, 1935–1948*, 22 TUL. L. REV. 384, 387, 392 n.22 (1948).

57. NANCY SAINT-PAUL, 1 SUMMERS OIL & GAS § 4:2 (3d ed. 2019).

Conventional oil and gas deposits involve fugacious resources, or those that can flow through porous rocks.[58] The original concept of ownership rights for developing these fugacious resources was the rule of capture.[59] As traditionally taught to first-year law students, the rule of capture describes "[t]he principle that wild animals belong to the person who captures them, regardless of whether they were originally on another person's land."[60] As relevant here, it is a "fundamental principle of oil-and-gas law[,] holding that there is no liability for drainage of oil and gas from under the lands of another so long as there has been no trespass and all relevant statutes and regulations have been observed."[61]

Applying the rule of capture to determine property rights over subsurface minerals involves two steps. First, application of the *ad coelum*[62] doctrine, which provides that an owner of a surface estate also owns everything directly above and below the surface.[63] Second, application of the principle that the surface owners can drill a well vertically anywhere within the boundaries of their lands and take possession of oil and gas resources from neighboring lands that might flow into that well from the common reservoir.[64] Thus, the rule of

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58. Richard J. McLaughlin, *Foreign Access to Shared Marine Genetic Materials: Management Options for a Quasi-Fugacious Resource*, 34 OCEAN DEV. & INT'L L. 297, 298 (2003). Note, however, that some shale oil deposits are so viscous (so-called "unconventional" shale oil deposits) that they are not fugacious. *See* ALAN J. MACFAYDEN & G. CAMPBELL WATKINS, *Petroleum and the Petroleum Industry: What Are They?*, *in* PETROPOLITICS 3, 3, 17 (2014).

59. *See, e.g.*, Coastal Oil & Gas Corp. v. Garza Energy Tr., 268 S.W.3d 1, 42 (Tex. 2008) (Johnson, J., concurring in part) ("The rationale for the rule of capture is the 'fugitive nature' of hydrocarbons").

60. *Rule of Capture*, BLACK'S LAW DICTIONARY (8th ed. 2004).

61. *Id.*

62. Bury v. Pope (1587), 78 Eng. Rep. 375, Cro. Eliz. 118 (KB). The phrase is commonly attributed to Lord Coke, but without a doubt it is more ancient in derivation than even the later usage in *Bury* in 1587. *See* Herbert David Klein, *Cujus Est Solum Ejus Est . . . Quousque Tandem?*, 26 J. AIR L. & COM. 237, 237–38 (1959) (describing the etiology of the Latin phrase epitomizing the *ad coelum* doctrine).

63. *See* Klein, *supra* note 62, at 237–38. *Cuius est solum, ejus est usque ad coelum et ad inferos* has been translated from the Latin by various authorities as, "'[h]e who owns the soil owns everything above (and below), from heaven (to hell)' or '[w]hose is the soil, his it is up to the sky' or '[h]e who possesses the land possesses also that which is above it' or '[h]e who has a right to the soil has a right even to the sky' or '[w]hose is the land, his is also what is above (and below) it.'" *See id.*

64. A.W. Walker, Jr., *Nature of the Landowner's Interest in Oil and Gas*, 17 MONT. L. REV. 22, 24–25 (1955). In certain states, title to the oil and gas is obtained through severance at the surface and not the location of the mineral originally under

capture incentivizes owners to drill anywhere on their properties, and with whatever density they can manage, to capture as much of the common reservoir as they can.[65] However, the rule of capture fails to protect the rights of other landowners who have common ownership to oil in the reservoir.

### *D. Correlative Rights*

In addition to the waste to society and the environment, wasteful practices also resulted in losses to the property rights of adjacent owners.[66] The concept of correlative rights first evolved to protect the economic interests of these adjacent owners.[67] Thus, at the time that U.S. waste law was evolving in the context of property held by those with life estates in contrast to remaindermen, another concept of waste was evolving between holders of "correlative rights" in the context of oil and gas extraction.[68]

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neighboring land. For example, compare Texas's adoption of the ownership in place theory with Oklahoma's adoption of the qualified ownership theory. 1 HOWARD R. WILLIAMS ET AL., WILLIAMS & MEYERS, OIL AND GAS LAW § 204 (2020).

65. Alabama v. U.S. Dep't of the Interior, 84 F.3d 410, 413 (11th Cir. 1996). The rule of capture allowed "invasion" of the property of adjacent landowners and was only limited by the possibility that the adjacent landowners also had the right to capture as many of your minerals as they could. *See, e.g.*, R.R. Comm'n of Tex. v. Manziel, 361 S.W.2d 560, 568–69 (Tex. 1962) (stating that it is "relevant to consider and weigh the interests of society . . . against the interests of the individual"); Brown v. Humble Oil & Refin. Co., 83 S.W.2d 935, 940 (Tex. 1935) (holding that a landowner's rights are limited only by the adjoining landowner's ability to capture the oil and gas first).

66. *See, e.g.*, Elliff v. Texon Drilling Co., 210 S.W.2d 558, 563 (Tex. 1948).

67. *Id.* at 562.

68. *See generally* David E. Pierce, *Developing a Correlative Rights Doctrine to Accommodate Development of Oil and Gas in Arkansas*, 68 ARK. L. REV. 407, 410–11 (2015)) [hereinafter Pierce, *Developing Correlative Rights*] (explaining the advance of correlative rights doctrine in Arkansas relating to natural resources); Pierce, *supra* note 44, at 778–79 (proposing a shift towards correlative rights doctrine as a way to better manage oil and gas resource while minimizing environmental harm); David E. Pierce, *Resolving Intra-Reservoir Horizontal Drilling Conflicts Using a Reservoir Community Analysis*, 90 N.D. L. REV. 249, 250–51 (2014) (explaining the disconnect in classic trespass doctrine with the geological structure of oil and gas reservoirs); Lewis M. Andrews, *The Correlative Rights Doctrine in the Law of Oil and Gas*, 13 S. CAL. L. REV. 185, 192–94 (1940) (cataloguing the origin of the correlative rights doctrine in the United States); Walter L. Summers, *The Modern Theory and Practical Application of Statutes for the Conservation of Oil and Gas*, 13 TUL. L. REV. 1, 4 (1938) ("[T]he legal relations of a landowner respecting oil and gas should be such as to encourage their production and consumption, but at the same time safeguard the interest of the public against loss of their economic values through wasteful production methods, and afford some proportionate adjustment of these

Extraction of minerals from a common reservoir creates an inevitable conundrum: any extraction by one owner of land necessarily impacts other landowners with property rights in the same reservoir.[69] Consequently, the concept of "correlative rights" arose.[70]

Correlative rights represent the landowners' privileges against one another, whose property bears a common fugacious resource, in lawfully taking only their proportional share of the resource.[71] If one owner within the pool commits waste, it can imperil the correlative rights of others, and there is an obligation to develop one's interest with due regard for the interests of the others in the pool.[72] Each mineral owner has both a coequal interest in the common subsurface resource and must respect the rights of the other owners of that resource.[73]

The common law first recognized correlative rights, not in the context of oil and gas but instead in the context of water or under lands within the same watershed.[74] Early water law gave owners of land

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values between the owners in a common source of supply."); Sidney J. Strong, *Application of the Doctrine of Correlative Rights by the State Conservation Agency in the Absence of Express Statutory Authorization*, 28 MONT. L. REV. 205, 205–06 (1967) ("The term 'correlative rights' may be said to encompass the land-owner's legally protected interest in the oil and gas beneath his property.").

69. Eugene Kuntz, *Correlative Rights in Oil and Gas*, 30 MISS. L.J. 1, 6 (1958) (describing the likely conflict when landowners extract minerals from a common reservoir under the rule of capture).

70. *Id.* at 1–2, 7.

71. *See id.* at 1–2. Correlative rights can be established by the common law or by statute. *See, e.g.*, LA. STAT. ANN. § 31:9 (2020) ("Landowners and others with rights in a common reservoir or deposit of minerals have correlative rights and duties with respect to one another in the development and production of the common source of minerals.").

72. *See* Kuntz, *supra* note 69, at 2–3.

73. *See* Tara K. Righetti, *The Incidental Environmental Agency*, 2020 UTAH L. REV. 685, 706 (2020); *see also* Yael R. Lifshitz, *The Geometry of Property*, U. TORONTO L.J. (forthcoming 2020) (manuscript at 27–28), https://www.utpjournals.press/doi/abs/10.3138/utlj-2020-0059 [https://perma.cc/L8TZ-JRZB] (providing a good example of the premise that vertical property regimes need to adapt when applied to a horizontal resource).

74. The doctrine of correlative rights to water involved not only surface water flowing in streams but also related groundwater. *See, e.g.*, Vill. of Tequesta v. Jupiter Inlet Corp., 371 So. 2d 663, 667–68 (1979) ("The right of the owner to ground water underlying his land is to the usufruct of the water and not to the water itself . . . . The right to use water does not carry with it ownership of the water lying under the land . . . . This 'right of user' may be protected by injunction, or regulated by law, but the right of user is not considered 'private property' requiring condemnation

bordering streams a right to use some of that water in its natural state.[75] This riparian regime allowed for use of the stream as long as it did not alter the flow or the quantity or quality of the water for downstream users.[76] This "natural flow theory" allowed only limited use and was replaced in most states that follow this streamside riparian rights water law by the doctrine of "reasonable use."[77]

Under reasonable-use riparian regimes, water rights were still tied to the banks of a river or stream.[78] However, owners of land bordering the stream were permitted to use the water so long as their use did not negatively impact the correlative rights of all other riparian landowners along that same watercourse to extract their equal shares.[79] Professor Christine A. Klein nicely summarizes the doctrine of reasonable use as follows:

> The determination of reasonableness is correlative, considering the reasonableness of a particular use not only in isolation, but also in comparison to other potentially reasonable uses of water. The calculus depends upon an evaluation of factors such as the purpose of the use, the economic and social value of the use, and the extent of harm it causes to other riparian users and, more recently, to the environment.[80]

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proceedings unless the property has been rendered useless for certain purposes." (citing Tatum Brothers, Real Est. & Inv. Co. v. Watson, 109 So. 623, 626 (Fla. 1926); Pounds v. Darling, 77 So. 666, 669 (Fla. 1918); Broward v. Mabry, 50 So. 826, 827 (Fla. 1909)).

75. A. DAN TARLOCK ET AL., WATER RESOURCE MANAGEMENT: A CASEBOOK IN LAW AND PUBLIC POLICY 126–27 (5th ed. 2002).

76. *Id.*

77. *Id.* at 122, 127.

78. *Id.* at 126–27.

79. Joseph W. Dellapenna, *The Right to Consume Water Under "Pure" Riparian Rights*, *in* 1 WATERS AND WATER RIGHTS § 7.02(a)(2) (Robert E. Beck & Amy K. Kelly eds., 2007).

80. Christine A. Klein et al., *Modernizing Water Law: The Example of Florida*, 61 FLA. L. REV. 403, 407 (2009) (citing RESTATEMENT (SECOND) OF TORTS § 850A (AM. L. INST. 1979)); *see also* Harris v. Brooks, 283 S.W.2d 129, 136 (Ark. 1955) (citing the principle that owners may use water to the extent that it is not detrimental to rights of other riparian owners); Mason v. Hoyle, 14 A. 786, 791 (Conn. 1888) (supporting the right to use water to one's best advantage, but not to render downstream parties' rights useless or unproductive); Hoover v. Crane, 106 N.W.2d 563, 565 (Mich. 1960) (citing the principle that when evaluating reasonable use, courts should consider, among other factors, use, extent, and duration). In times of shortage, all riparians share the limited water supply. RESTATEMENT (SECOND) OF TORTS § 850A cmt. a (asserting that during "drought or temporary water shortage, it is usually reasonable to require the water and the harm to be shared" among landowners along the same watercourse); *see*

The doctrine of correlative rights to prevent a neighbor from doing harm to one's use of water migrated over to a similar right to prevent harm to a neighbor's right to oil and gas resources.[81] The Pennsylvania Supreme Court was one of the first courts to liken damage of oil and gas development to damage of groundwater resources.[82] One of the first Texas cases to address correlative rights for oil and gas resources, *Elliff v. Texon Drilling Co.*,[83] cited the groundwater-based Pennsylvania authority to support its holding.[84]

Part of the beauty of correlative rights is the doctrine's straddle between the "compartmentalized notions of exclusive ownership" and the sharing of "property held as a commons."[85] This creates an "'intermediate stage' between the commons and fully individualized property [that] may induce a group to preserve a resource and to 'avoid dissipating time and effort—and the resources themselves—in unproductive disputes and wasteful attempts to grab the most.'"[86]

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*also* Erin Ryan, *A Short History of the Public Trust Doctrine and Its Intersection with Private Water Law*, 38 VA. ENV'T L.J. 135, 183 (2020).

81. Walker, *supra* note 64, at 23; *see also* Hague v. Wheeler, 27 A. 714, 717 (Pa. 1893).

82. *Hague*, 27 A. at 717 ("Notwithstanding the fugitive nature of oil and gas, I think it will not be doubted that if a party by negligent operations upon adjacent land injures the flow of oil wells . . . he would be liable in damages to the well owners so injured. Such a liability as to wells of water was established . . . and the right to gas or oil would seem to be of as high a character as the right to water." (citing Collins v. Chartiers Val. Gas Co., 18 A. 1012 (Pa. 1890))).

83. 210 S.W.2d 558 (Tex. 1948).

84. *Id.* at 562 ("No owner should be permitted to carry on his operations in reckless or lawless irresponsibility, but must submit to such limitations as are necessary to enable each to get his own."). Interestingly, the doctrines have been applied in both directions. *Hague* applied groundwater correlative rights theory to oil and gas, but more recently, the Texas Supreme Court has applied oil and gas correlative rights theory to groundwater. *See* Edwards Aquifer Auth. v. Day, 369 S.W.3d 814, 830, 832 (Tex. 2012) (holding, as a matter of common law, groundwater in Texas is owned just as oil in the ground is owned in place even though either may be drained). *But cf.* City of Lubbock v. Coyote Lake Ranch LLC, 440 S.W.3d 267, 274–75 (Tex. App. 2014) (stating that "simply because a landowner may own the groundwater beneath his land in a manner similar to the way in which a landowner owns oil and gas beneath his land does not necessarily translate into the analogy being taken further" to support an extension of the accommodation doctrine to the groundwater context).

85. Tara K. Righetti, *Correlative Rights and Limited Common Property in the Pore Space: A Response to the Challenge of Subsurface Trespass in Carbon Capture and Sequestration*, 47 ENV'T L. REP. 10,420, 10,432–34 (2017) (arguing that application of the correlative rights doctrine would result in the most effective development of subsurface pore space for geologic carbon sequestration).

86. *Id.* at 10,433 (footnote omitted).

However, the breadth of correlative rights was irregular. The common law concepts of correlative rights varied depending upon the ownership interest in the resource.[87] Under the common law, injury to the common resource appeared to be a prerequisite to recovery for an aggrieved neighbor. For example, the Texas Supreme Court noted in *Elliff*:

> While we are cognizant of the fact that there is a certain amount of reasonable and necessary waste incident to the production of oil and gas to which the non-liability rule must also apply, we do not think this immunity should be extended so as to include the negligent waste or destruction of the oil and gas.[88]

Thus, under the common law rule of correlative rights, owners' rights to extract oil and gas from their property, as well as to capture it from their neighbors' properties, did not give them absolute rights. "The opportunity to capture a just and equitable share of a resource is only valuable to the extent that others in the resource are precluded from diminishing that right. Thus, correlative rights in oil and gas arise from, and are subordinate to, the concept of prohibition of waste."[89]

Regulation was designed to protect correlative rights, and the common law regime of oil and gas regulation has primarily shifted to a statutory scheme.[90] Statutes created some of the parameters to determine what was "reasonable and legitimate drainage from the common pool" without resorting to extensive litigation to determine

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87. *Elliff*, 210 S.W.2d at 561 ("In Texas, and in other jurisdictions, a different rule exists as to ownership. In our state the landowner is regarded as having absolute title in severalty to the oil and gas in place beneath his land. The only qualification of that rule of ownership is that it must be considered in connection with the law of capture and is subject to police regulations." (citing Lemar v. Garner, 50 S.W.2d 769 (Tex. 1932)); Humphreys-Mexia Co. v. Gammon, 254 S.W. 296 (Tex. 1923); Waggoner Est. v. Sigler Oil Co., 19 S.W.2d 27 (Tex. 1929); Texas Co. v. Daugherty, 176 S.W. 717 (Tex. 1915); Brown v. Humble Oil & Refin. Co., 83 S.W.2d 935, 940 (Tex. 1935)). It is beyond the scope of this article to address the various property regimes for surface or groundwater or for oil and gas in various states. Many of them are now controlled by legislation. *See generally* Kerstin Mechlem, *Groundwater Governance: The Role of Legal Frameworks at the Local and National Level—Established Practice and Emerging Trends*, 8 WATER 347 (2016). Likewise, legislation or regulations might best clarify the property ownership status of wind rights.

88. *Elliff*, 210 S.W.2d at 562.

89. Righetti, *supra* note 85, at 10,435 (footnotes omitted).

90. Marvin W. Jones, *Groundwater Fair Share*, *in* CHANGING FACE OF WATER RIGHTS ch. 8, 8.1–II (2019) ("[C]orrelative rights arise from ownership. They are not created by regulation; instead, regulation must be designed to protect these rights." (emphasis omitted)).

whether it constituted waste that would subject an operator to potential liability.[91] Initially, legislators justified their intervention by invoking the protection of private correlative rights.[92] Gradually, regulators successfully married correlative rights to the public good of preventing waste.[93] Definitions of correlative rights link the concept to waste:

> *Correlative rights* when used with respect to lessees of adjacent leases, means the right of each lessee to be afforded an equal opportunity to explore for, develop, and produce, *without waste*, minerals from a common source.[94]

The following section, drawing on a fifty-state survey of oil and gas waste statutes in the United States, will tease out some of the key elements of these state statutory definitions of waste.

## II. STATE RESPONSES TO ONSHORE WASTE

Although the term waste is not easily defined, in the oil and gas context it means the loss of potentially recoverable oil and gas products, and "[t]he prevention of waste is conservation."[95] Although environmental waste has received increased recognition in recent

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91. *Elliff*, 210 S.W.2d at 562 ("These laws and regulations are designed to afford each owner a reasonable opportunity to produce his proportionate part of the oil and gas from the entire pool and to prevent operating practices injurious to the common reservoir. In this manner, if all operators exercise the same degree of skill and diligence, each owner will recover in most instances his fair share of the oil and gas.").

92. Pierce, *Developing Correlative Rights*, *supra* note 68, at 409 (explaining that, initially, property owners viewed regulation based on the protection of private property rights as less intrusive than regulation for an indefinite public good); *see also* Bandini Petroleum Co. v. Superior Ct., 284 U.S. 8, 20–21 (1931) ("The District Court of Appeal apparently thought it doubtful whether the State might restrict or regulate the production of oil or gas 'on the theory of the public's interest in their natural resources' . . . .").

93. *See, e.g.*, *Bandini*, 284 U.S. at 22 ("If the statute be viewed as one regulating the exercise of the correlative rights of surface owners with respect to a common source of supply of oil and gas, the conclusion that the statute is valid upon its face . . . is fully supported by the decisions of this Court."); Champlin Refin. Co. v. Corp. Comm'n of Okla., 286 U.S. 210, 233–34 (1932) (upholding a proration order on public right to prevent waste).

94. 30 C.F.R. § 205.105 (2010) (emphasis added); *see also* WYO. STAT. ANN. § 30-5-101(a)(ix) (2021) ("'Correlative rights' shall mean the opportunity afforded the owner of each property in a pool to produce, so far as it is reasonably practicable to do so *without waste*, his just and equitable share of the oil or gas, or both, in the pool . . . ." (emphasis added)); NEB. REV. STAT. § 57-903(1), (6) (2021); NEV. REV. STAT. § 522.021 (2021); UTAH CODE ANN. § 40-6-2(2) (LexisNexis 2021); VT. STAT. ANN. tit. 29, § 503(3) (2021); WASH. REV. CODE § 78-52.010(19) (2021).

95. 8 WILLIAMS & MEYERS, OIL AND GAS LAW SCOPE (2020).

years,[96] most oil and gas law sources recognize two main forms of "waste" addressed above: physical waste and economic waste.[97]

### *A. The Model Act*

All oil and gas producing states have statutes defining "waste," yet the items included vary from state to state.[98] Many states have formulated a definition based upon the Model Oil and Gas Conservation Act ("Model Act"), drafted by the Interstate Oil and Gas Conservation Commission:

> "Waste" means:
>
> (A) the inefficient, excessive, or improper use of reservoir energy or unnecessary dissipation of reservoir energy;
>
> (B) the inefficient storing of oil or gas;

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96. *See, e.g.*, Patrick Siler, Note, *Hydraulic Fracturing in the Marcellus Shale: The Need for Legislative Amendments to New York's' Mineral Resources Law*, 86 ST. JOHN'S L. REV. 351, 355, 369–70, 376–77, 382 (2012) (discussing, inter alia, how legislatures should broaden the definition of waste to include environmental waste); *see also* Michael Pappas, *Anti-Waste*, 56 ARIZ. L. REV. 741, 745 (2014) (enumerating five societal values to define waste: "(1) economic efficiency; (2) human flourishing; (3) concern for future generations; (4) stability and consistency; and, (5) ecology"). To illustrate different perspectives on waste, Pappas reiterates an excerpt from Marc Reisner's *Cadillac Desert* where Mulholland says not damming and flooding Yosemite Park for hydropower is "goddamned waste!" *Id.* at 743 n.3.

97. Pappas, *supra* note 96, at 743 n.3.

98. ALA. CODE § 9-17-1(20) (2021); ALASKA STAT. § 31.05.170(15) (2021); ARIZ. REV. STAT. ANN. § 27-501(20) (2021); ARK. CODE ANN. § 15-72-102(15) (2021); CAL. PUB. RES. CODE § 3300 (West 2021); COLO. REV. STAT. § 34-60-103(11–13) (2021); FLA. STAT. § 377.19(31) (2021); GA. CODE ANN. § 12-4-42(17) (2021); IDAHO CODE § 47-310(32–33) (2021); 225 ILL. COMP. STAT. 725/1 (2021); IND. CODE § 14-37-7-3.5(a) (2021); IOWA CODE § 458A.2(19) (2021); KAN. STAT. ANN. § 55-602 (2021); KY. REV. STAT. ANN. § 353.520(2) (West 2021); LA. STAT. ANN. § 30:3(16) (2021); MD. CODE ANN. ENV'T § 14-404 (West 2021); MISS. CODE ANN. § 53-1-3(l) (2021); MO. REV. STAT. § 259.050(15) (2021); MONT. CODE ANN. § 82-1-101(16)(a) (2021); NEB. REV. STAT. § 57-903(1)(a); NEV. REV. STAT. § 522.039; N.M. STAT. ANN. § 70-2-3 (2021); N.Y. ENV'T CONSERV. LAW § 23-0101(20) (McKinney 2021); N.C. GEN. STAT. § 113-389(14) (2021); N.D. CENT. CODE § 38-08-02 (2021); OR. REV. STAT. § 520.005(15) (2021); 58 PA. STAT. AND. CONS. STAT. ANN. § 402(2) (West 2021); S.C. CODE ANN. § 48-43-10(A) (2021); S.D. CODIFIED LAWS § 45-9-2(15) (2021); TENN. CODE ANN. § 60-1-101(13) (2021); TEX. NAT. RES. CODE ANN. § 85.046 (West 2021); UTAH CODE ANN. § 40-6-2(2); VT. STAT. ANN. tit. 29, § 503(27); VA. CODE ANN. § 45.1-361.1 (2021); WASH. REV. CODE § 78.52.010(23); W. VA. CODE § 22-6-1 (2020); WYO. STAT. ANN. § 30-5-101(a)(i) (2021). *Compare* N.C. GEN. STAT. § 113-389(14) (listing several definitions of waste, including underground waste); *with* N.Y. ENV'T CONSERV. LAW § 23-0101(20) (providing a definition of waste that does not include underground waste).

> (C) the locating, drilling, equipping, operating, or producing of an oil or gas well in a manner that causes or tends to cause a reduction in the quantity of oil or gas ultimately recoverable from a reservoir under prudent and proper operations, the drilling of unnecessary wells, or the loss or destruction of oil or gas either at the surface or below the surface;
>
> (D) the production of oil or gas in excess of pipeline, marketing, or storage capacities, in excess of reasonable market demand, in excess of the amount reasonably required for properly drilling, completing, testing, or operating a well or other facilities for recovering, processing, or transporting oil, gas, or by-products, or in excess of the amount otherwise utilized on the acreage from which the oil or gas is produced; or
>
> (E) other dissipation, production, or use of oil or gas underground or above ground, or in storage, that is careless, needless, or without valuable result.[99]

It is obvious when states base their statutes on the Model Act because of the repetition of language from subsection (A), notably "inefficient, excessive, or improper" use.[100] Of the thirty-six states with readily identifiable definitions of "waste," twenty-nine utilize some, if not all, of the language from the Model Act.[101]

This analysis will focus on three of the five Model Act provisions: (1) unnecessary dissipation of reservoir energy—subsection (A) in the

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99. MODEL OIL AND GAS CONSERVATION ACT § 1(24) (INTERSTATE OIL & GAS COMPACT COMM'N 2004).

100. *Id.*

101. The twenty-nine states are: Alabama, ALA. CODE § 9-17-1(20)(a), Alaska, ALASKA STAT. § 31.05.170(15)(A), Arizona, ARIZ. REV. STAT. ANN. § 27-501(20)(b), Arkansas, ARK. CODE ANN. § 15-72-102(15)(A), Florida, FLA. STAT. § 377.19(31)(a), Georgia, GA. CODE ANN. § 12-4-42(17)(A), Idaho, IDAHO CODE § 47-310(33), Iowa, IOWA CODE § 458A.2(19)(b), Louisiana, LA. STAT. ANN. § 30:3(16)(a), Mississippi, MISS. CODE ANN. § 53-1-3(l)(i), Missouri, MO. REV. STAT. § 259.050(15)(b), Montana, MONT. CODE ANN. § 82-11-101(16)(a)(ii), Nebraska, NEB. REV. STAT. § 57-903(1)(a), Nevada, NEV. REV. STAT. § 522.039(1), New Mexico, N.M. STAT. ANN. § 70-2-3(A), New York, N.Y. ENV'T CONSERV. LAW § 23-0101(20)(b), North Carolina, N.C. GEN. STAT. § 113-389(14)(a), North Dakota, N.D. CENT. CODE § 38-08-02(19)(b), Oregon, OR. REV. STAT. § 520.005(15)(a), Pennsylvania, 58 PA. STAT. AND CONS. STAT. ANN. § 192(f), South Carolina, S.C. CODE ANN. § 48-43-10(A)(2), South Dakota, S.D. CODIFIED LAWS § 45-9-2(15)(b), Texas, TEX. NAT. RES. CODE ANN. § 85.046(a)(7), Utah, UTAH CODE ANN. § 40-6-2(29)(a), Vermont, VT. STAT. ANN. tit. 29, § 503(27)(A), Virginia, VA. CODE ANN. § 45.1-361.1, Washington, WASH. REV. CODE § 78.52.010(23)(b), West Virginia, W. VA. CODE ANN. § 22-6-1(v), Wyoming, WYO. STAT. ANN. § 30-5-101(a)(i)(B).

model definition; (2) reduction in the quantity ultimately recoverable—subsection (C) in the model definition; and (3) production in excess of reasonable market demand—subsection (D) in the model definition. This analysis will also address another provision within subsection (C) of the model definition—(4) "the drilling of unnecessary wells"—which evokes societal, as well as economic, concerns.[102]

*1. Dissipation of reservoir energy*

Conventional oil and gas deposits involve underground traps.[103] Oil and gas migrate through porous rocks until they encounter a nonporous and impervious formation, which then traps the oil and gas in a reservoir.[104] Although the reservoir exists within the tiny spaces of a porous rock, it also is often layered with salt water (because oil evolves from marine deposits), oil, and then gas on top and infused throughout the oil.[105] The water and gas in the deposit create pressure that traditionally assists in recovery by "propel[ling] the oil or gas to the well bore."[106]

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102. MODEL OIL AND GAS CONSERVATION ACT § 1(24)(c) (INTERSTATE OIL & GAS COMPACT COMM'N 2004).

103. This contrasts with unconventional deposits, such as shale oil or tight gas that could not be exploited until the development of hydraulic fracturing, three-dimensional seismic, and directional drilling. *See, e.g.*, K.K. DUVIVIER, ENERGY LAW BASICS 273–78 (2017).

104. Edwin Cey et al., *Oil Formation*, ENERGY EDUC. (Jan. 4, 2019), https://energyeducation.ca/encyclopedia/Oil_formation [https://perma.cc/2XDP-5JST].

105. *Natural Gas Explained*, U.S. ENERGY INFO. ADMIN. (Dec. 9, 2020), https://www.eia.gov/energyexplained/natural-gas [https://perma.cc/VMS6-VGJJ].

106. HOWARD R. WILLIAMS & CHARLES J. MEYERS, MANUAL OF OIL AND GAS TERMS 922 (Patrick H. Martin & Bruce M. Kramer eds., 10th ed. 1997) (defining "reservoir energy"); *see* 1 NANCY SAINT-PAUL, SUMMERS OIL AND GAS § 4:27 (3d ed. 2020) ("In the states defining the waste of oil and gas as including the waste of reservoir energy, the conservation agencies have the authority to make rules and regulations governing the use of reservoir energy, including the authority to require gas-oil ratios and to fix those ratios . . . . These statutes were directed principally to preventing the waste of gas in the production of oil and authorized conservation agencies to fix gas-oil production ratios. Some of these statutes defined waste as including the waste of gas energy and water drive."); Note, *Conservation of Natural Gas and the Federal-State Conflict,* 64 COLUM. L. REV. 888, 898 (1964) ("[M]ost conservation statutes include in the definition of waste the inefficient, improper, or excessive dissipation of reservoir energy. Reservoir energy includes, in addition to gas pressure, water motivated by hydrostatic pressure, gravitational force, and expansion of reservoir oil upon the release of pressure." (footnotes omitted)); Owen L. Anderson & Ernest E. Smith, *Exploratory Unitization*

When a reservoir is depleted too quickly, natural gas pressure experiences accelerated dissipation and salt water can mix with the oil.[107] As a result, much of the oil that could have been captured may be stranded underground.[108]

Because efficient primary recovery drilling techniques allow exploitation of a deposit over a shorter period of time, they also reduce total development and operating expenses.[109] Aside from extra expenses, attempting to recover additional oil after the primary phase requires additional expenditures of energy.[110] Perhaps most

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*Under the 2004 Model Oil and Gas Conservation Act: Leveling the Playing Field*, 24 J. LAND RES. & ENV'T L. 277, 278 (2004) ("The resulting 'flush' production that resulted from the drilling of too many wells inefficiently dissipated the natural reservoir energy that pushed the oil and gas through the reservoir and into well bores, thereby causing underground waste. Because of this rapid dissipation of internal reservoir pressure, hydrocarbons that would otherwise have been produced became unrecoverable."); Brad Secrist, Note, *Not All "Units" Are Created Equal: How* Hebble v. Shell Western E & P, Inc. *Missed an Opportunity to Curb the Expansion of Fiduciary Obligations in Oklahoma Oil and Gas Law*, 65 OKLA. L. REV. 157, 159 (2012) ("Over-drilling can also damage the natural reservoir energy necessary to extract the oil and gas and result in irreparable damage to the recoverability of valuable hydrocarbons. Once the natural reservoir energy has dissipated, extraction of the oil or gas often becomes economically unfeasible.").

107. *See* Righetti, *supra* note 73, at 693.

108. *Id.* Through careful preservation of pressure, a gas-cap driven well can yield oil recoveries of twenty-five to fifty percent, and water driven wells can recover seventy-five to eighty percent of the oil in a reservoir. JACQUELINE LANG WEAVER, UNITIZATION OF OIL AND GAS FIELDS IN TEXAS: A STUDY OF LEGISLATIVE, ADMINISTRATIVE, AND JUDICIAL POLICIES 12–13 (1986); *see also* AM. PETROLEUM INST., STATISTICAL ANALYSIS OF CRUDE OIL RECOVERY AND RECOVERY EFFICIENCY 15 (2d ed. 1984), https://pslcolombia.com/documentos/BULL%20D14%20Statistical%20Analysis%20of%20Crude%20Oil%20Recovery%20and%20Re1.pdf [https://perma.cc/5VL4-99N3]. A key mechanism adopted by regulators to avoid the unnecessary dissipation of reservoir energy is the "maximum efficient rate of production" or MER. WEAVER, *supra* note 108, at 14. If an operator adheres to the MER for a particular well, it should result in a maximum rate of ultimate recovery of oil for the entire reservoir. Exceeding the MER results in waste. *Id.* Sometimes, oil left in a field can be collected through secondary recovery operations. *Id.* Secondary recovery usually involves the injection of gas or water in five spot patterns with the injection wells on the outside and the recovery or producing well in the center. *Id.* at 16. Secondary recovery is "a poor substitute for producing oil efficiently from the start." *Id.* at 17.

109. *Id.* at 17–18.

110. Enhanced oil recovery includes a variety of processes that go beyond traditional primary and secondary recovery methods. *Enhanced Oil Recovery*, OFF. OF FOSSIL ENERGY & CARBON MGMT., U.S. DEP'T OF ENERGY, https://www.energy.gov/fe/science-innovation/oil-gas-research/enhanced-oil-recovery [https://perma.cc/JL2H-MT98]; Klaas van 't Veld & Owen R. Phillips, *The Economics of Enhanced Oil*

importantly, improper primary recovery techniques may have injured the geologic formation, which, along with price considerations, may make secondary recovery completely infeasible.[111]

In conclusion, because of the mechanics of how oil is produced and the composition of salt water, oil, and gas in each separate reservoir, dissipation of reservoir energy can result in considerable waste or loss of the resource.

*2. Reduction in the quantity ultimately recoverable*

There are other ways that valuable resources, like oil and gas, may be unnecessarily left in the ground. Fires and explosions in early oil fields caused damage not only to improvements on the surface but also to the subsurface oil resources.[112] For example, in *Elliff v. Texon Drilling Co.*, a sudden uprush of uncontrolled flow from an oil well, or "blowout," on the defendant's land constituted a violation of plaintiff's correlative rights.[113] As the *Elliff* court noted:

> [N]otwithstanding the fact that oil and gas beneath the surface are subject both to capture and administrative regulation, the fundamental rule of absolute ownership of the minerals in place is not affected in our state. In recognition of such ownership, our courts, in decisions involving well-spacing regulations of our Railroad Commission, have frequently announced the sound view that *each landowner should be afforded the opportunity to produce his fair share of the recoverable oil and gas beneath his land,* which is but another way of recognizing the existence of correlative rights . . . .[114]

Part of allowing operators to recover their "fair share" is to seek "the largest ultimate recovery."[115] Thus, every state statute including this

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*Recovery*: *Estimating Incremental Oil Supply and $CO_2$ Demand in the Powder River Basin*, 31 ENERGY J. 31, 32 (2010).

111. WEAVER, *supra* note 108, at 17.

112. *See, e.g.*, People's Gas Co. v. Tyner, 31 N.E. 59, 59 (Ind. 1892) (enjoining a landowner from using nitroglycerin to extract natural gas because the explosive would "greatly injure and damage" the land above and below the earth's surface); Wronski v. Sun Oil Co., 279 N.W.2d 564, 570–71 (Mich. Ct. App. 1979) (evaluating the damage caused by an oil company's illegally produced wells); Elliff v. Texon Drilling Co., 210 S.W.2d 558, 559 (Tex. 1948) (determining damages to a neighbor's land from wells that blew out and caught fire).

113. *Elliff*, 210 S.W.2d at 562–63.

114. *Id.* at 562 (emphasis added).

115. OKLA. STAT. tit. 52, § 86.2(A) (2021). Note, however, that in 2019, Colorado shifted focus away from maximum production and amended the definition of waste so that waste "[d]oes not include the nonproduction of [oil or] gas from a formation if necessary to protect public health, safety, and welfare, the environment, or wildlife

language from the Model Act identifies unnecessary actions that "cause a reduction in the quantity of oil or gas ultimately recoverable from a reservoir" as waste.[116]

The Model Act seems expansive in its inclusion of several actions that might reduce the quantity of resource ultimately recoverable, "specifically locating, drilling, equipping, operating, or producing . . . [a] well."[117] The first item in the list—well location—is "the second important factor in increasing recovery rates." Consequently, orders by regulatory agencies addressing well location can significantly decrease waste.[118]

Three primary techniques for determining well locations have been used in the oil and gas context. One of the first techniques that was used in the oil and gas context is set spacings between wells (or well spacings) without particular regard to a geologic formation.[119] The second is pooling, which is the "process of combining small tracts into an area of sufficient size to merit a well permit under the field's applicable spacing rule."[120]

Third is "unitization," which is "the process of combining all or a large part of the acreage of an entire field into a unit" where owners of the separate tracts overlaying the reservoir participate in joint and coordinated operation of the field.[121] Unitization is more efficient and economical than the other two strategies of spacing or pooling,[122] and unitized fields have achieved dramatically improved recovery rates,

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resources as determined by the [Colorado Oil and Gas Conservation] commission." COLO. REV. STAT. § 34-60-103(11)(b) (2021).

116. MODEL OIL AND GAS CONSERVATION ACT § 1(24)(C) (INTERSTATE OIL & GAS COMPACT COMM'N 2004). *See also supra* Section II.A.1 (discussing controlling production rates through MER as one of the primary ways to maximize recovery in an oil and gas context).

117. MODEL OIL AND GAS CONSERVATION ACT § 1(24)(C) (INTERSTATE OIL & GAS COMPACT COMM'N 2004).

118. WEAVER, *supra* note 108, at 13–14. The first factor is rate of production. *Id.* at 13.

119. In Texas, the typical statewide spacing rule is one oil well per 40 acres and one gas well per 640 acres. *Id.* at 21.

120. *Id.* at 7, 21.

121. *Id.*; *see also* 30 C.F.R. § 250.2(jjj) (1986) ("'Unitization' means the combining or consolidation of separately owned lease interests for the joint exploration or development of a reservoir or potential hydrocarbon accumulation under the terms of a unit agreement."). Unitization is not currently defined under 30 C.F.R. § 550.105.

122. WEAVER, *supra* note 108, at 25.

reducing physical waste.[123] In addition, if the entire deposit is not considered as a unit, then the other two techniques well spacing and pooling—can result in an unfair allocation of the increased recovery that these rules can make possible. Thus, compulsory unitization offers the best strategy for addressing the tension between conservation and correlative rights.[124]

A second component of subsection (C) of the Model Act includes actions that not only *actually cause* "a reduction in the quantity of oil or gas ultimately recoverable from a reservoir," but also actions that *tend to cause* a reduction in the quantity of oil or gas ultimately recoverable from a reservoir.[125] Thus, the Model Act seems to broaden its scope to cover not only situations where causation is proved but also to those where the actions might "tend[] to cause" reductions. To balance this comprehensive coverage, however, the Model Act provides some protection for an extractor. Immediately following the "tend[] to cause" wording, the Model Act adds the phrase "under prudent and proper operations,"[126] thus injecting a "prudent operator" negligence standard potentially weakened by poor industry practices.

States vary in how broadly or narrowly they have chosen to modify the model language to protect different actors. For example, at least six states place a heavier burden on the party extracting by making them responsible for any "locating, spacing, drilling, equipping, operating or producing . . . in a manner that results or may result in reducing the quantity . . . ultimately recoverable" without any additional language about "prudent and proper operations."[127]

*3. Production in excess of reasonable market demand*

While dissipation of a well's pressure and reduction in the quantity of the resource ultimately recoverable directly address physical waste, regulating oil and gas production to address market demand is entirely different. These provisions address economic waste by permitting

123. *Id.* at 29 & n.36 (citing MID-CONTINENT OIL & GAS ASS'N, HANDBOOK ON UNITIZATION OF OIL POOLS 44–55 (1930) (noting recovery of oil in Cromwell field would be doubled with unitization)).

124. *Id.* at 25, 29–33 (explaining why a compulsory unitization process is needed).

125. MODEL OIL AND GAS CONSERVATION ACT § 1(24)(C) (INTERSTATE OIL & GAS COMPACT COMM'N 2004).

126. *Id.*

127. *See, e.g.*, OR. REV. STAT. § 520.005(15)(a) (2021); ALASKA STAT. § 31-05-170(15)(A) (2021); ARK. CODE ANN. § 15-72-102(15)(A) (2021); COLO. REV. STAT. § 34-60-103(13)(a)(II) (2021).

regulators to "proration," or restrict production, based on market demand.[128]

The glut of oil in East Texas in the early 1930s resulted in a sharp decline in the price per barrel.[129] By May of 1931, when the first prorationing orders were issued, East Texas oil production represented one-third of U.S. consumption.[130] However, the price of oil in East Texas at that time was ten cents per barrel in contrast to the price of one dollar per barrel just the year before.[131] Some courts struck down the early prorationing rules because the rules' objective was to raise the price of oil, not to prevent physical waste. The latter of which was the scope of the regulating agency's authority under the Texas statute.[132] However, once the Texas legislature explicitly granted the authority for market demand prorationing, the practice of prorationing was upheld.[133]

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128. 8 WILLIAMS & MEYERS, OIL AND GAS LAW SCOPE (2020) (defining prorationing as the "[r]estriction of production by a state regulatory commission, usually on the basis of market demand [wherein] [t]he commission determines what amount shall be produced in a state during a given period of time and then allocates this total amount among the producing fields in the state"); *see also* 16 Tex. Admin. Code § 3.38(a)(3) (defining prorationing units as "[t]he acreage assigned to a well for the purpose of assigning allowables and allocating allowable production to the well"). Historically, using the geographic surface area of a tract or portion of a tract as a factor in allocating the volume of oil or gas to be produced from a well arose from the way in which proration of oil and gas production developed in the early part of the 20th century. Robert G. Hargrove & Ana Maria Marsland, *Proration Units: "You keep using that word, I don't think it means what you think it means!"* (Apr. 20, 2018).

129. J. Howard Marshall & Norman L. Meyers, *Legal Planning of Petroleum Production*, 41 YALE L.J. 33, 38 (1931). *See generally* DAVID F. PRINDLE, PETROLEUM POLITICS AND THE TEXAS RAILROAD COMMISSION 19–55 (1981) (describing the history of oil and gas politics from 1930 to 1935); Robert E. Hardwicke, *Legal History of Conservation of Oil in Texas, 1938* A.B.A. SEC. MIN. L. 214–68 (describing the history of oil conservation in Texas); WEAVER, *supra* note 108, at 37–68 (explaining the early history of Texas legislation and unitization).

130. Hardwicke, *supra* note 129, at 232.

131. *Cf.* CHARLES A.S. HALL & KENT KLITGAARD, ENERGY AND THE WEALTH OF NATIONS 234 (2d ed. 2018).

132. *See, e.g.*, MacMillan v. R.R Comm'n of Texas, 51 F.2d 400, 402, 405 (W.D. Tex. 1931), *rev'd sub nom.* R.R. Comm'n of Texas v. MacMillan, 287 U.S. 576 (1932); People's Petroleum Producers, Inc. v. Smith, 1 F. Supp. 361, 365 (E.D. Tex. 1932).

133. *See, e.g.*, Flannery v. State, 85 S.W.2d 1052, 1053 (Tex. Civ. App. 1935) (holding that a statutory authority to limit the production of crude petroleum oil more than reasonable market demand grants the power to enact orders to that end).

The goal of market demand prorationing was "to provide price stability to oil and gas producers who faced cycles of boom and bust under the unbridled rule of capture."[134] In contrast to restrictions on oil production to prevent physical waste and protect reservoir integrity, market demand prorationing restricts production below the maximum efficient rate (MER) levels to prevent oversupply in a market that might result in lower prices.[135]

Although there are formal definitions of economic waste that are distinct from physical waste, many state oil and gas statutes blur the definitions.[136] Yet, several state statutes specifically include provisions like subsection (D) of the Model Act that defines waste as including production "in excess of . . . [the] reasonable market demand."[137] Regulating commissions may not have the power to proration or take other measures to address the economic impacts of oil and gas production in the absence of such explicit language.[138] This could explain why legislatures at one time expressly included this authority in the statutes.[139]

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134. 2 ERNEST E. SMITH & JACQUELINE LANG WEAVER, TEXAS LAW OF OIL AND GAS 10.131(B)(1) (2d ed. 2021).

135. *Id.* at 10.1(B)(1); *see also* Danciger Oil & Ref. Co. v. R.R. Comm'n of Texas, 49 S.W.2d 837, 843 (Tex. Civ. App. 1932) evaluating the effects of over production on market prices), *rev'd sub nom*, Danciger Oil & Ref. Co. of Texas v. R.R. Comm'n of Texas, 56 S.W.2d 1075 (Tex. 1933). *But cf.* Champlin Ref. Co. v. Corp. Comm'n of Okla., 286 U.S. 210, 236–37 (1932) (market demand prorationing was upheld on the basis that it prevented physical waste). The Maximum Efficient Rate of production or MER was discussed above and represents the maximum rate at which oil can be produced in a field without injury to the reservoir based on engineering studies. *See supra* note 108. *See generally* SMITH & WEAVER, *supra* note 134 (explaining the concepts of MER and Market Demand); *Maximum Efficiency Rate*, PETROPEDIA, https://www.petropedia.com/definition/7510/maximum-efficiency-rate-mer [https://perma.cc/V27F-Y3T3] (explaining MER).

136. *See, e.g.*, ARK. CODE ANN. § 15-72-102(15) (specifying waste as physical and listing examples of economic waste); COLO. REV. STAT. § 34-60-103(11) (prescribing various definitions of waste including physical and economic); 225 ILL. COMP. STAT. § 725/1 (defining waste as physical with examples of economic waste).

137. *See, e.g.*, N.M. STAT. ANN. § 70-2-3; TEX. NAT. RES. CODE ANN. § 85.046.

138. *Cf.* Flannery v. State, 85 S.W.2d 1052, 1053 (Tex. Civ. App. 1935) (arguing that a statutory authority to limit "the production of crude petroleum oil in excess of . . . reasonable market demand" grants the power to enact orders to that end).

139. Because OPEC and the international market now set the price of oil, states do not generally proration anymore. *See* OUR MISSION, OPEC https://www.opec.org/opec_web/en/about_us/23.htm (last visited Oct 4, 2021) (describing the purpose of OPEC).

*4. Drilling of unnecessary wells*

Subsection (C) of the Model Act includes within its definition of waste "the drilling of unnecessary wells."[140] While the majority of the thirty-nine states with oil and gas waste statutes do not address unnecessary wells either in their definition of waste or of correlative rights, ten do.[141] The Eleventh Circuit explained the phenomenon:

> The problem with the rule of capture is that it encourages a tract owner to build wells near his border so as to drain not only the reserves underlying his own tract, but also the reserves underlying a neighboring tract. The neighboring tract owner, in order to protect his mineral rights, must then build offsetting wells—most advantageously right across the border from his neighbors' wells—and start production or risk losing his reserves. Each tract owner then has an incentive virtually to race to drain the reservoir as quickly as possible to capture as much oil or gas as he can. The result is (1) economic waste in drilling unnecessary wells; (2) a corresponding heightened risk of damage to the environment; and (3) physical waste of the oil or gas itself because the faster production occurs, the lower the long-term recovery will be from the reservoir. Because of its negative effects, nearly every state has abrogated the rule of capture legislatively with well-spacing rules, production regulations, and/or other conservation mechanisms.[142]

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140. MODEL OIL AND GAS CONSERVATION ACT § 1(24)(C) (INTERSTATE OIL & GAS COMPACT COMM'N 2004).

141. States with unnecessary wells in their definition of waste: ALASKA STAT. § 31-05-170(15)(J) (2021); KY. REV. STAT. ANN. § 353.520(2)(f) (West 2021); 58 PA. STAT. § 402(2)(12)(D)(ii) (West 2021) ("'Waste' means . . . *[t]he drilling of more wells than are reasonably required to recover, efficiently and economically, the maximum amount of oil and gas from a pool.*" (emphasis added)); S.D. CODIFIED LAWS § 45-9-2(15)(d) (2021); UTAH CODE ANN. § 40-6-2(29)(c)(ii) (LexisNexis 2021); VT. STAT. ANN. tit. 29, § 503(27) (2021); WASH. REV. CODE § 78.52.010(23)(b) (2021); W. VA. CODE § 22–6–1(v) (2011). States with unnecessary wells mentioned under correlative rights: OR. REV. STAT. §§ 520.005(9) (2021) ("'Protect correlative rights' means that the action or regulation by the board affords a reasonable opportunity to each person entitled thereto to recover or receive the oil or gas in the tract or tracts of the person or the equivalent thereof, *without being required to drill unnecessary wells or to incur other unnecessary expense to recover or receive such oil or gas or its equivalent.*" (emphasis added)); VA. CODE ANN. § 45.1-361.1 (repealed Oct. 1, 2021). *But cf.* Righetti, *supra* note 73, at 704 (recognizing that Texas "has long acknowledged the 'virtues' of drilling unnecessary wells" and that the Wyoming legislature disregarded waste by "reject[ing] language that would have permitted [consideration of] 'the drilling of wells not reasonably necessary to effect an economic maximum ultimate recovery of oil and gas from a pool'").

142. Alabama v. U.S. Dep't of Interior, 84 F.3d 410, 413 (11th Cir. 1996) (citations omitted); *see also* Righetti, *supra* note 73, at 704 ("Utah defines waste more expansively

As the excerpt notes, offset wells result in multiple injuries including (1) economic waste, (2) heightened risk of damage to the environment, and (3) physical waste of the resource itself from dissipation of reservoir energy or damage to the reservoir that prevents maximum recovery.[143]

With respect to economic waste, not only do the offset wells create added expense, but they also should not have been drilled at all because of the damage or potential damage they inflict. If neighboring tract owners do not "offset drill" to recover what they can to prevent drainage into the well across the border, those owners also may become liable to royalty holders or others who own an interest in production of those minerals.[144] Overall, the result is that both operators are forced to swallow higher production costs for the oil that they produce. Higher production cost per barrel is "a very real cost to the individual producer," but society might write it off as simply "a transfer of income between [private] producers."[145]

However, excess wells have a societal impact as well. In addition to reduced overall recovery, the proliferation of unnecessary wells impacts the neighboring landowners by increasing their costs of production. Moreover, society as a whole pays a greater price because more infrastructure is required than what would be necessary to most effectively recover the resources in a particular reservoir.[146] Thus,

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to include the drilling of unnecessary wells to recover the same resource, thus resulting in an inefficient allocation of capital, increased costs of production, higher costs to the consumer, and unnecessary consumption of surface resources.").

143. *Supra* note 142 and accompanying text.

144. Texas Pac. Coal & Oil Co. v. Barker, 6 S.W.2d 1031, 1036 (Tex. 1928) (explaining duty to drill offset or additional wells, if, considering costs and probable profit, an ordinarily prudent person would do so). *See, e.g.*, Barnard v. Monongahela Natural Gas Co., 65 A. 801, 802–03 (Pa. 1907) (discussing the need for landowners to protect their oil and gas from adjoining landowners has led to "[n]o doubt many thousands of dollars . . . expended 'in protecting lines' in oil and gas territory"); Kelly v. Ohio Oil Co., 49 N.E. 399, 401 (Ohio 1897) (finding an oil company had the right to use its own premises to secure and appropriate oil that came to the land through natural channels"); Texaco Inc. v. Indus. Comm'n of State of N.D., 448 N.W.2d 621, 623 n.2 (N.D. 1989) (explaining that a land owner whose drilling operations drain the lands of adjacent landowners is not liable to the injured landowners, leaving them no remedy but to "go and do likewise"); *see also* MAURICE H. MERRILL, THE LAW RELATING TO COVENANTS IMPLIED IN OIL AND GAS LEASES 94–117 (2d ed. 1940).

145. Weaver, *supra* note 108, at 27 (*referencing* Stephen L. McDonald, *Petroleum Conservations in the United States: An Economic Analysis* at 59–110 (Baltimore, MD., The Johns Hopkins University Press for Resources for the Future, 1971)).

146. *Id.*

"[p]rivate actions become socially inefficient."[147] While the short-term effect might be a drop in the price of oil, the long-term impact is a "price of oil above that which would prevail with unitization."[148] From society's viewpoint, the quantity of resource recovered is "less than optimal," and the price is "above the socially optimal level."[149]

A "heightened risk of damage to the environment" is also a consequence of unnecessary wells.[150] In the context of oil wells, more wells mean more chances of spills, seepage, fugitive gases, or groundwater contamination.[151] Some might argue that this risk could also include the environmental degradation and destruction necessitated by mining for the materials needed to construct these unnecessary wells.[152]

In recent years, as more states turn to public health and decarbonization or "green" initiatives, legislatures have been further amending the definition of waste to place more focus on public health and environmental concerns. An amendment to the Colorado oil and gas statutes states that waste "[d]oes not include . . . nonproduction" or less than maximum recovery from a reservoir if developing a well would negatively impact public health, safety, and welfare; the environment; or wildlife resources.[153]

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147. *Id.*

148. *Id.* at 27.

149. *Id.* at 28.

150. Alabama v. U.S. Dep't of Interior, 84 F.3d 410, 413 (11th Cir. 1996).

151. *Cf.* Nichola Groom, *Special Report: Millions of Abandoned Oil Wells Are Leaking Methane, a Climate Menace*, REUTERS (June 16, 2020, 7:14 AM), https://www.reuters.com/article/us-usa-drilling-abandoned-specialreport/special-report-millions-of-abandoned-oil-wells-are-leaking-methane-a-climate-menace-idUSKBN23N1NL [https://perma.cc/L4EZ-TRE6] (explaining the dangers posed by the over 3.2 million wells abandoned in the United States).

152. *See, e.g.*, Maria Kielmas, *The Types of Metals Used in the Oil & Gas Industry*, CHRON, https://smallbusiness.chron.com/types-metals-used-oil-gas-industry-55352.html [https://perma.cc/2ETA-QGEJ] (discussing the central role played by metals such as steel, nickel, copper, titanium, chromium, and molybdenum in drilling for gas and oil); TRAVIS L. HUDSON ET AL., METAL MINING AND THE ENVIRONMENT 7 (Am. Geological Inst. ed., 1999) (listing environmental consequences of metal mining such as physically disturbing landscapes, increasing the acidity of soil, degrading surface and groundwater quality, and releasing contaminating emissions).

153. COLO. REV. STAT. § 34-60-103(13)(b) (2021) ("[Waste d]oes not include the nonproduction of oil or gas from a formation if necessary to protect public health, safety, and welfare, the environment, or wildlife resources as determined by the commission.").

## III. FEDERAL RESPONSES TO OFFSHORE WASTE

The original Outer Continental Shelf Lands Act[154] ("OCS Lands Act") granted the Secretary of the Interior the power to create rules and regulations (1) "to provide for the prevention of waste and conservation of the natural resources of the outer Continental Shelf" and (2) for "the protection of correlative rights therein."[155] This Part will address how the terms "prevention of waste" and "protection of correlative rights" have been applied in the context of offshore oil and gas development. This Part will also consider the evolving definition of waste in the context of vented and flared gas.

### *A. Outer Continental Shelf Lands Act*

The federal government has its own definition of waste in offshore oil and gas operations:

> Waste of oil, gas, or sulphur means:
>
> (1) The physical waste[156] of oil, gas, or sulphur;
>
> (2) The inefficient, excessive, or improper use, or the unnecessary dissipation of reservoir energy;
>
> (3) The locating, spacing, drilling, equipping, operating, or producing of any oil, gas, or sulphur well(s) in a manner that causes or tends to cause a reduction in the quantity of oil, gas, or sulphur ultimately recoverable under prudent and proper operations or that causes or tends to cause unnecessary or excessive surface loss or destruction of oil or gas; or

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154. 43 U.S.C. § 1334(a).

155. *Id.*

156. While the definition of physical waste has varied historically and geographically, it "is commonly understood in the oil and gas industry as referring to operational losses in oil and gas production resulting from either: surface loss or destruction of oil and gas; or, underground loss or destruction of oil and gas." Union Pac. Res. Co. v. Texaco, Inc., 882 P.2d 212, 224 (Wyo. 1994) (citation omitted). Although some states include the flaring or venting of natural gas within their definitions of "waste," the federal OCS Lands Act rules do not currently address flaring or venting. In November of 2016, the Obama administration published a final Waste Prevention Rule that regulated venting and flaring on federal lands. *See* Waste Prevention, Production Subject to Royalties, and Resource Conservation, 81 Fed. Reg. 83,008 (Nov. 18, 2016). However, the Trump administration rescinded the new rule. *See* Waste Prevention, Production Subject to Royalties, and Resource Conservation, 83 Fed. Reg. 49,184 (Sept. 28, 2018) (amending 43 C.F.R. § 3160 and § 3170). This recission has since been successfully challenged in California and Wyoming. California v. Bernhardt, 472 F. Supp. 3d 573, 632 (N.D. Cal. 2020); Wyoming v. U.S. Dep't of Interior, 493 F. Supp. 3d 1046, 1085–87 (D. Wyo. 2020).

(4) The inefficient storage of oil.[157]

This definition differs from the Model Act,[158] which has been adopted by most states.[159] Notably, the federal definition only includes two of the items discussed above: (1) "unnecessary dissipation of reservoir energy"—subsection (A) in the model definition; and (2) "reduction in the quantity of resource ultimately recoverable" subsection (C) in the model definition.[160] The federal regulation does not include the (3) "production in excess of reasonable market demand"—subsection (D) in the model definition.[161] Finally, while the federal regulation does not include (4) "drilling of unnecessary wells"[162]—in subsection (C) of the model definition—that language is included in other portions of the OCS Lands Act. The analysis below will address all four items.

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157. 30 C.F.R. § 550.105 (providing the definition of waste for the Bureau of Ocean Management's operations, such as leasing, under the Outer Continental Shelf (OCS) Lands Act); 30 C.F.R. § 250.105 (defining "[w]aste of oil, gas, or sulphur" using the definition applicable to the Bureau of Safety and Environmental Enforcement's activities under the OCS Lands Act); *see also* 43 C.F.R. § 3160.0-5 (defining waste in the context of onshore federal leases as "any act or failure to act by the operator that is not sanctioned by the authorized officer as necessary for proper development and production and which results in: (1) A reduction in the quantity or quality of oil and gas ultimately producible from a reservoir under prudent and proper operations; or (2) avoidable surface loss of oil or gas"). Perhaps by coincidence, it is very similar to the definition in New York State. N.Y. ENV'T CONSERVATION LAW § 23-0101(20) (McKinney 2021) ("'Waste' means a. Physical waste, as that term is generally understood in the oil and gas industry; b. The inefficient, excessive or improper use of, or the unnecessary dissipation of reservoir energy; c. The locating, spacing, drilling, equipping, operating, or producing of any oil or gas well or wells in a manner which causes or tends to cause reduction in the quantity of oil or gas ultimately recoverable from a pool under prudent and proper operations, or which causes or tends to cause unnecessary or excessive surface loss or destruction of oil or gas; d. The inefficient storing of oil or gas; and e. The flaring of gas produced from an oil or condensate well after the department has found that the use of the gas, on terms that are just and reasonable, is, or will be economically feasible within a reasonable time.").

158. MODEL OIL AND GAS CONSERVATION ACT § 1(24) (INTERSTATE OIL & GAS COMPACT COMM'N 2004) (discussing the definitions of inefficient storage of oil in the Model Act).

159. *Id.*; *see also supra* note 127 and accompanying text (explaining the definition of inefficient storage of oil under the Model Act).

160. *Id.* § 1(24)(A), (C).

161. *Id.* § 1(24)(D).

162. *Id.* § 1(24)(C).

*1. Dissipation of reservoir energy*

Conventional oil reservoirs trap oil and natural gas under pressure as discussed in Section II.C.1 above.[163] If an operator does not maintain proper pressures as it develops the deposit, the natural pressure in the reservoir that would provide propulsion for recovery is dissipated and can be lost completely.[164] The result may be leaving large quantities of oil in the ground or worse, if the reservoir is damaged, loss of any opportunity to recover that oil subsequently with alternative recovery methods.[165] This definition of waste is unique to the gas and fluid flows of conventional trapped-oil reservoirs.

*2. Reduction in the quantity ultimately recoverable*

The definition for this portion of the federal regulation is expansive, including consideration of numerous activities that might cause waste: "locating, spacing, drilling, equipping, operating, or producing of any . . . well(s)."[166] Like the Model Act, the federal regulation also provides some leeway on causation. It covers both activities that actually "cause" as well as those that "tend[] to cause" reductions.[167]

Two portions of the federal regulation limit its broad reach. The federal regulation, like the Model Act, includes the "prudent and proper operations" language that provides some protection for operators.[168] This language permits invocation of industry standards or government regulations as a defense. Under this relaxed standard of reasonableness for negligence, there is little incentive for operators to perform better if others are not.[169] This wording can also work in the

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163. *See supra* Section II.C.1.

164. *See supra* note 106 and accompanying text.

165. *See supra* notes 108–11 and accompanying text.

166. 30 C.F.R. § 250.105. One of the only limitations might be application of *expressio unius est exclusio alterius* canon of construction that holds exclusion of anything not specifically listed, which could possibly narrow the scope. *See Expressio unius est exclusio alterius*, BLACK'S LAW DICTIONARY (11th ed. 2019).

167. MODEL OIL AND GAS CONSERVATION ACT § 1(24)(c) (Interstate Oil & Gas Compact Comm'n 2004); 30 C.F.R. § 250.105.

168. MODEL OIL AND GAS CONSERVATION ACT § 1(24)(c) (Interstate Oil & Gas Compact Comm'n 2004).

169. *See, e.g.*, Louisiana *ex rel.* Guste v. United States, 832 F.2d 935, 944 (5th Cir. 1987) (finding defendants' "prudent operations in accord with federal regulations and under substantial oversight by the MMS" outweighed plaintiffs' showing of a reduction of resource recoverable); *see also* Wyoming v. U.S. Dep't of the Interior, 493 F. Supp. 3d 1046, 1074 (D. Wyo. 2020) (criticizing the 2016 Waste Prevention Rule as overly broad because it designated some losses of natural gas as "avoidable," and therefore

other direction: one operator's compromise might create an industry standard below what other prudent operators would recommend.[170] Finally, this section allows recovery for surface loss or destruction of oil or gas but only if "unnecessary" or "excessive," which raises the burden of proof required.[171]

If reducing the quantity ultimately recoverable represents waste, then avoiding it by maximizing recovery represents the other side of the ameliorative waste coin.[172] As discussed in Section II.C.2 above, cooperative development or unitization are the vehicles that best wed the protection of correlative rights with achieving the most efficient and economic recovery of a resource.[173] The federal rules explicitly authorize mandates for "joint development and unitization" of OCS leases as a way to conserve resources, protect correlative rights, enhance federal royalty interests, and prevent waste.[174]

*3. Production in excess of reasonable market demand*

It is logical that the federal definition might choose not to include "production . . . in excess of reasonable market demand"[175] from subsection (D) of the Model Act. Though not included in many of the state statutes, this provision primarily works to protect operators from dramatic price variations.[176] Thus, it addresses economic protections for mostly private harms, with which the government need not interfere.

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subject to royalties, "without determining whether a reasonable and prudent operator would, given the circumstances, capture and market the gas."). *See generally infra* Section III.D (addressing ways in which the federal government can use comparable regulations and unitization-like approaches to maximize development of U.S. offshore wind resources).

170. *See infra* Section III.D.2.

171. *See* MODEL OIL AND GAS CONSERVATION ACT § 1(24)(A) (Interstate Oil & Gas Compact Comm'n 2004); 30 C.F.R. § 250.105.

172. *See, e.g.*, Breton Energy, L.L.C. v. Mariner Energy Res., Inc., 764 F.3d 394, 396–97 (5th Cir. 2014) (reversing and remanding the district court's grant of a motion to dismiss under FRCP 12(b)(6)–therefore rejecting plaintiff's claim for waste under several theories, including reduction of the quantity of recoverable oil and gas when one company's well may have penetrated and drained plaintiff's oil and gas rights).

173. *See supra* Section II.C.2.

174. 30 C.F.R. § 250.1300 ("[T]he purpose of joint development and unitization" of OCS leases is "(a) [c]onserv[ing] natural resources; (b) [p]revent[ing] waste; and/or (c) [p]rotect[ing] correlative rights, including Federal royalty interests.").

175. MODEL OIL AND GAS CONSERVATION ACT § 1(24)(D) (Interstate Oil & Gas Compact Comm'n 2004).

176. *See supra* notes 134–35 and accompanying text.

*4. Drilling of unnecessary wells*

There are numerous public benefits from discouraging the use of duplicative infrastructure that does not increase overall recovery of a resource. While the federal rule definition of waste does not explicitly include protections against "drilling of unnecessary wells," this language may not be necessary; the federal government already has the authority, which it uses, to encourage or force lessees to enter into cooperation or unitization agreements.[177] Such agreements require operators who have acquired separate leases to collaborate holistically. The result is both minimizing costs and maximizing the total resource recovery.[178] This goal protects the correlative co-owners of the resource as well as society's interest in the optimal development of the nation's resources.

Cases interpreting the federal rule have held that omission of explicit language in the rule to recover for the cost of additional wells means that the federal regime does not recognize this form of waste. For example, in *Louisiana ex rel. Guste v. United States*,[179] the federal government used its discretion to refuse a unitization agreement that would have included the Louisiana with a private federal lessee in an

177. *Supra* Section II.C.2 (discussing the federal government's authority to act). 30 C.F.R. § 250 subpart M contains regulations that specifically address BSEE's regulation of offshore unitization. *See also*, Alabama v. U.S. Dep't of Interior, 84 F.3d 410, 418 (11th Cir. 1996) (holding that, once the Department of the Interior (DOI) has negotiated in good faith to reach a cooperative development agreement with coastal states and federal private leases and no agreement is reached, the DOI may proceed unilaterally to authorize a plan, which the court noted is "closely akin to section 8(g)(3), which gives the DOI the authority to enter into 'unitization or other royalty sharing agreement[s]' with states regarding reservoirs straddling the federal/state border"); New OCS Unitization Rules—Authority of the Sec'y to Segregate Partially Unitized Offshore Leases, 1980 I.D. LEXIS 102 (M36927); Sun Oil Co., 93 Interior Dec. 95, 113 (IBLA 1986); Noble Energy, Inc. v. Salazar, 691 F. Supp. 2d 14, 25 (D.D.C. 2010) (holding that the federal government may exclude leases from a unitization agreement and IBLA's procedures for reaching its own conclusion as to the propriety of excluding the lessees' leases from their respective units were unbiased and based on an evidentiary record); Aera Energy LLC v. Salazar, 691 F. Supp. 2d 25, 36–37 (D.D.C. 2010) (denying summary judgment using the same reasoning as *Noble Energy*).

178. Howard R. Williams, *Conservation of Oil and Gas*, 65 HARV. L. REV. 1155, 1156 (1952) (describing how oil and gas conservation is coterminous with "attaining maximum production from known fields by more efficient utilization of reservoir energy").

179. 832 F.2d 935 (5th Cir. 1987).

oil and gas reservoir under both federal and state submerged lands.[180] Louisiana argued that it was entitled to additional royalties from the private lessee under a theory of excessive drainage away from Louisiana's wells and into the lessee's. Louisiana reasoned, under a theory of waste, that Louisiana and its lessee would have to drill unnecessary wells unless there was an agreement.[181] The court disagreed, pointing explicitly to the fact that the federal regulation did not include any language about the drilling of unnecessary wells:

> The Secretary has defined "correlative rights" as the right of adjacent lessees to be afforded an equal opportunity to explore for, develop, and produce hydrocarbons without waste. 30 C.F.R. § 250.2(i). "Waste" is defined as the physical waste of hydrocarbons, the dissipation of reservoir energy, and the reduction of the amount of ultimately recoverable hydrocarbons. 30 C.F.R. § 250.2(qq). *Notably, economic losses inherent in the cost of drilling wells to exploit a common pool are excluded from this definition.*[182]

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180. *Id.* at 942. Shortly after certiorari was denied, Congress amended the OCS Lands Act to require "cooperative development," effectively unitization, in similar situations in the future. 43 U.S.C. § 1334(j) ("Cooperative development of common hydrocarbon-bearing areas (1) Findings (A) The Congress of the United States finds that the unrestrained competitive production of hydrocarbons from a common hydrocarbon-bearing geological area underlying the Federal and State boundary may result in a number of harmful national effects, including—(i) the drilling of unnecessary wells, the installation of unnecessary facilities and other imprudent operating practices that result in economic waste, environmental damage, and damage to life and property; (ii) the physical waste of hydrocarbons and an unnecessary reduction in the amounts of hydrocarbons that can be produced from certain hydrocarbon-bearing areas; and (iii) the loss of correlative rights which can result in the reduced value of national hydrocarbon resources and disorders in the leasing of Federal and State resources. (2) Prevention of harmful effects The Secretary shall prevent, through the cooperative development of an area, the harmful effects of unrestrained competitive production of hydrocarbons from a common hydrocarbon-bearing area underlying the Federal and State boundary." (footnote omitted)).

181. *Guste*, 832 F.2d at 937. The court granted summary judgment for the defendant holding on this issue that the mandatory division of revenues under the amendments to § 8(g) of the Outer Continental Shelf Lands Act were intended to fully compensate the state government for drainage losses, and thus, the Secretary of the Interior had no duty under § 8(g) to enter into a unitization or royalty sharing agreement to compensate states for drainage losses. *Id.* at 1312.

182. Louisiana *ex rel.* Guste v. United States, 656 F. Supp. 1310, 1320 (W.D. La. 1986), *aff'd*, 832 F.2d 935 (5th Cir. 1987 (emphasis added). This case was effectively reversed by statute shortly thereafter by inclusion of the specific remedy requested by Louisiana in a "Miscellaneous" provision added to the OCS Land Act in 1989. Oil Pollution Act of 1990, Pub. L. No. 101-380, § 6004, 104 Stat. 484 (1990) ("(b) Exception for West Delta Field.—Section 5(j) of the Outer Continental Shelf Lands

Just a year after *Guste*, however, a federal district court in a different district of Louisiana addressed unnecessary wells in *Clark Oil Producing Co. v. Hodel*.[183] Plaintiff, Clark Oil challenged the Secretary of the Interior's authority to unitize its leases, but the court granted summary judgment on this issue in favor of the Secretary of the Interior, holding the unitization order was proper.[184] Specifically, the court noted that it was reasonable for government officials to conclude that preventing the drilling of unnecessary wells that "would not have increased overall production" aided "conservation," explaining:

> An order requiring unitization to prevent the drilling of an unnecessary well furthers the interest of conservation because well drilling and completion operations are a potential source of pollution. In addition, the drilling of an unnecessary well entails the diversion of scarce drilling equipment and expert manpower from more productive uses. Potentially adverse effects of separate operations can be avoided only by careful scrutiny of each drilling application.[185]

Clark Oil's leases were granted in 1971, and the USGS Conservation Manager ordered unitization between Clark Oil and Shell Oil in 1975.[186] Clark Oil challenged this order on a number of grounds

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Act, as added by this section, shall not be applicable with respect to Blocks 17 and 18 of the West Delta Field offshore Louisiana. (c) Authorization of Appropriations.—There are hereby authorized to be appropriated such sums as may be necessary to provide compensation, including interest, to the State of Louisiana and its lessees, for net drainage of oil and gas resources as determined in the Third Party Factfinder Louisiana Boundary Study dated March 21, 1989. For purposes of this section, such lessees shall include those persons with an ownership interest in State of Louisiana leases SL10087, SL10088 or SL10187, or ownership interests in the production or proceeds therefrom, as established by assignment, contract or otherwise. Interest shall be computed for the period March 21, 1989 until the date of payment."). However, the statute does not change the court's analysis and the tension between the *Guste* and *Clark* cases concerning omission of specific language.

183. 667 F. Supp. 281 (E.D. La. 1987).

184. *Id.* at 283, 290. Clark Oil challenged the Secretary of Interior's authority to unitize its leases. However, the court held not only that the authority was proper but also that it was reasonable for the IBLA to conclude that the prevention of the drilling of unnecessary wells was "in the interest of conservation" as contemplated by 43 U.S.C. § 1334 and 30 C.F.R. § 250.50. *Id.*

185. *Id.* at 285 (citations omitted) ("The Director [of the USGS] found that Shell intended to drill additional wells in order to compete with Sun's production, and that permission to do so had been denied informally by USGS. '[A] sufficient number of wells already had been drilled to drain the reservoir' and additional wells would have been unnecessary because they would not have increased overall production.").

186. *Id.* at 283.

primarily focused on the meaning of "conservation."[187] Although the OCS Lands Act authorized consideration of correlative rights in addition to conservation, the federal regulation in effect at the time of Clark Oil's unitization order only authorized compulsory unitization "in the interest of conservation."[188] Finding against Clark Oil, the court followed the rule of deference to an agency's reasonable interpretation of a statute made by the agency charged with its administration and stated:

> It is clear that the Department of the Interior had interpreted the term in the interest of conservation in a broad sense to encompass the protection of the environment long before the 1975 order of unitization. Additionally there existed case law interpreting the phrase "in the interest of conservation" to encompass all the natural resources of the outer continental shelf, not only the mineral resources. As stated in *Union Oil*, "[t]he Secretary is responsible for conserving marine life, recreational potential, and aesthetic values, as well as the resources of gas and oil."[189]

Despite these conflicting opinions within Louisiana, only the *Guste* case was appealed. On appeal, Louisiana abandoned the "unnecessary wells" claim that would not be supported by the express definition of waste in the Code of Federal Regulations.[190] Instead, Louisiana focused on the defendants' "well spacing and production practices," which plaintiff-appellants argued "tend to cause reduction in the quantity of gas ultimately recoverable."[191] The court found evidence submitted to support this conclusion was outweighed by the defendants' "prudent

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187. *Id.* at 288–89 (challenging the Conservation Manager's order on four grounds: (1) it did not contain the required evidence that unitization was necessary for conservation; (2) since unitization did not increase ultimate gas recovery, the order of unitization is invalid as "conservation" in this context refers exclusively to conserving the greatest ultimate recovery of oil and gas; (3) "economic waste" should not be a factor in determining whether unitization is proper; and (4) the claim that unitization serves conservation by reducing environmental risks is legally defective and evidentially deficient).

188. *Id.* at 289 (citing 30 C.F.R. § 250.50 (1975)).

189. *Id.* at 289–90 (fifth alteration in original) (citations omitted) (citing Union Oil Co. Cal. v. Morton, 512 F.2d 743, 749 (9th Cir. 1975)). An applicant must show that its proposal will "not unreasonably interfere with other uses of the OCS," 30 C.F.R. § 585.606(a)(3) (2016), nor "cause undue harm or damage to natural resources; life (including human and wildlife); property; the marine, coastal, or human environment; or sites, structures, or objects of historical or archaeological significance." § 585.606(a)(4).

190. Louisiana *ex rel.* Guste v. United States, 832 F.2d 935, 944 (5th Cir. 1987).

191. *Id.*

operations in accord with federal regulations and under substantial oversight by the MMS."[192]

In addition to these comparisons between the federal rule and the sections of the Model Act, there are at least two significant takeaways from this analysis of the federal law of waste and correlative rights. First, the language in the OCS Lands Act envisions protections for all OCS resources, even if the federal regulations addressing waste in the oil and gas context do not include similar language. For example, the OCS Lands Act allows the Secretary of the Interior "to provide for the "prevention of waste and conservation of the natural resources of the outer Continental Shelf, and the protection of correlative rights therein."[193] Notably, the OCS Lands Act says, "protection of correlative rights *therein*," specifically referencing the outer Continental Shelf and not limiting protection to mineral rights alone.[194]

The *Clark Oil* court identified some other items that warrant protection under the OCS Lands Act: limiting "a potential source of pollution," minimizing "disturb[ance of] marine life," and preventing "diversion of scarce drilling equipment and expert manpower from more productive uses."[195] The *Clark Oil* court also refused to entertain how many unnecessary wells were needed, saying that preventing even one unnecessary well was sufficient.[196]

Second, the tension between the *Guste* case in the Eastern District of Louisiana, which held that the failure of the federal definition of waste to explicitly mention unnecessary wells meant there was no protection for such additional costs, and the *Clark Oil* case's recognition of

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192. *Id.*

193. Outer Continental Shelf Lands Act, Pub. L. No. 109-58, 119 Stat. 694 (codified as 43 U.S.C. § 1334(a)).

194. *Id.* (emphasis added).

195. Clark Oil Producing Co. v. Hodel, 667 F. Supp. 281, 285–86 (E.D. La. 1987) ("An order requiring unitization to prevent the drilling of an unnecessary well furthers the interest of conservation because well drilling and completion operations disturb marine life and are a potential source of pollution. Potentially adverse cumulative effects of separate operations on natural resources can be reduced or eliminated by minimizing the total number of wells drilled on different leases.").

196. *Id.* at 286 ("It can be argued that the prevention of the drilling of one additional well does not eliminate a risk to the resources of the OCS so as to constitute a significant conservation purpose. This argument cannot be accepted. There would be no merit to a dispute as to how many unnecessary wells constitute too many. Suffice it to say that the prevention of drilling of one unnecessary well avoids an unnecessary risk to natural resources and constitutes conservation of such resources so as to justify unitization.").

unnecessary wells as waste sufficient to justify unitization, shows the broad range of discretion available to those interpreting the regulations.[197] The current federal regulations do not include "drilling of unnecessary wells" within the definition of waste, and these cases illustrate why language explicitly requiring the avoidance of unnecessary wells or other infrastructure needs to be included to prevent varying interpretations that do not consider this factor.[198] Such language would provide real protection for this problem in all circumstances.

### *B. 2016 Waste Prevention Rules Proposed by Bureau of Land Management*

A discussion of waste in the context of federal oil and gas development would not be complete without mention of the 2016 Waste Prevention Rules proposed by the Bureau of Land Management (BLM) to address the loss of natural gas through venting, flaring, and leaking.[199] The Mineral Leasing Act of 1920[200] ("MLA") requires the BLM to ensure that lessees "use all reasonable precautions to prevent waste of oil or gas developed in the land."[201] The 2016 rules represented the first amendment in thirty years and were intended to update the regulations to reflect new technologies that better capture natural gas and to address the loss of royalties to the federal government—and thus to the American people—of an estimated three to fourteen million dollars per year.[202]

The 2016 Waste Prevention Rules were immediately challenged in court and, after a number of appeals, were vacated by a federal district

197. *See Guste*, 832 F.2d at 944; *Clark Oil*, 667 F. Supp. at 290.
198. *See Guste*, 832 F.2d at 944; *Clark Oil*, 667 F. Supp. at 290.
199. *See* 43 C.F.R. 3179.6-.10 (2017).
200. Mineral Leasing Act of 1920, Pub. L. No. 66-146, 41 Stat. 437.
201. 30 U.S.C. § 225.
202. 81 Fed. Reg. 83,014 (Nov. 18, 2016) (assuming a three percent discount rate to annualize capital costs). The BLM estimated the benefits of the rule would significantly outweigh the costs. *Id.* While the costs were estimated at $110-$275 million per year (at a three percent discount rate), the benefits, in the form of cost savings to the industry, were estimated at $209-$403 million per year (modelling the social cost of methane with a three percent discount rate). *Id.* at 83,068–69. Natural gas production was estimated to increase from nine to forty-one billion cubic feet per year, but crude oil production is expected to decline by up to 3.2 million barrels per year. *Id.* at 83,014. These minimal changes signify that the rule should not adversely affect the price or supply of energy markets. *Id.*

court in Wyoming.[203] The court cited discussion of the social cost of methane, and the inclusion of those benefits in the cost-benefit analysis, as evidence that the BLM was attempting to regulate air quality, rather than waste, and that regulation was beyond the BLM's statutory authority under the Mineral Leasing Act and a violation of states' authority under the Clean Air Act.[204]

Furthermore, the court in Wyoming noted that its decision might be different if this were a "new policy created on a blank slate," evoking detrimental reliance and industry standards of reasonableness for a prudent operator to support its decision to vacate the key provisions of the rule.[205]

## IV. WIND WAKES AND WASTE

Wind turbines create downwind turbulence much like a boat making waves in the water as it moves.[206] Wind wakes result in two distinct forms

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203. Wyoming v. U.S. Dep't of the Interior, 493 F. Supp. 3d 1046, 1074, 1087 (D. Wyo. 2020) (criticizing the 2016 Waste Prevention Rule as overly broad because it designated some losses of natural gas as "avoidable," and therefore subject to royalties, "without determining whether a reasonable and prudent operator would, given the circumstances, capture and market the gas").

204. *Id.* at 1068–70.

205. *Id.* at 1084 (quoting Fed. Commc'n Comm'n v. Fox Television Stations, Inc., 556 U.S. 502, 515 (2009) (plurality opinion), vacated, 613 F.3d 317 (2nd Cir. 2010)) ("When an agency's new policy 'rests upon factual findings that contradict those which underlay its prior policy[,] or when its prior policy has engendered serious reliance interests that must be taken into account,' the agency must 'provide a more detailed justification than what would suffice for a new policy created on a blank slate.'" (alteration in original)); *id.* at 1072 ("The MLA incorporates the 'prudent operator' standard through the provisions requiring lessees to exercise '*reasonable* diligence, skill, and care' in the operation of the lease and subjecting Federal leases to the condition that lessees will use 'all *reasonable* precautions to prevent waste of oil or gas developed in the land.' . . . The exercise of 'reasonable diligence' and employment of 'reasonable precautions' under the MLA do not require an operator to render its operations uneconomical by capturing and marketing uneconomic gas." (citation omitted)).

206. J.K. Lundquist et al., *Costs and Consequences of Wind Turbine Wake Effects Arising from Uncoordinated Wind Energy Development*, 4 NATURE ENERGY 26, 26 (2019); Kimberly E. Diamond & Ellen J. Crivella, *Wind Turbine Wakes, Wake Effect Impacts, and Wind Leases: Using Solar Access Laws as the Model for Capitalizing on Wind Rights During the Evolution of Wind Policy Standards*, 22 DUKE ENV'T L. & POL'Y F. 195, 195 (2011); *see* TROY A. RULE, SOLAR, WIND AND LAND: CONFLICTS IN RENEWABLE ENERGY DEVELOPMENT 50 (2014) [hereinafter RULE, CONFLICTS] (explaining how downward wake impacts can create a claim for nuisance); *see also* Troy Rule, *A Downwind View of the Cathedral: Using Rule Four to Allocate Wind Rights*, 46 SAN DIEGO L. REV. 208–09 (2009) [hereinafter Rule, *Using Rule Four*] (explaining that downwind wake effects can stretch more than half a mile).

of loss: (a) equipment damage and (b) energy loss. Sections A and B of this Part will address these forms of loss. Next, Section C explains how U.S. onshore wind developers have resorted to a "moat mentality" to protect themselves against these forms of loss. Finally, Section D will apply the waste analysis from the previous sections of this Article to wind development, concluding with some recommendations for avoiding waste in U.S. offshore development.

### *A. Equipment Damage*

If wind turbines are spaced too closely—between three and ten rotor diameters (RD)—the turbulence behind the upwind turbine can cause turbine blade fatigue."[207] In addition, the uneven load on one side or another leads to lower efficiencies, diminished output, less cost-effective operation, and a shorter service life for the gears and other overall components of the turbine.[208] This increases the operation and maintenance costs, decreases the life of the turbine, and can create safety concerns.[209]

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207. K.K. DuVivier & Brendan Mooney, *Moat Mentality: Onshore and Offshore Approaches to Wind Waking*, 1 NOTRE DAME J. EMERGING TECH. 1, 12–15 (2020). It should be noted that wind patterns vary around the country and the world. At some locations, the wind rose, or graphic measurement of the direction of wind volume and speed over time, shows the wind blowing in a widely varying or bimodal pattern. A bimodal wind rose suggests that one wind plant might be upwind for part of the time, waking a downwind plant. But when the wind direction changes, that wind plant may then become the downwind plant, which is now waked by the plant that it previously impacted. *See* Aaron Walters, *A Fast Way to Find Fatigue Damage on Wind Turbines from Partial Waking*, https://www.et.byu.edu/~vps/ME505/AAEM/V4-10.pdf [https://perma.cc/GLD2-EN3W] (explaining a study on wind conditions that can increase turbine's lifespan and reduce future maintenance costs); *see also* Ben DuBose, *New Rotor Blade Inspection Methods for Offshore Wind Turbines*, MATERIALS PERFORMANCE (May 4, 2020, 12:58 PM), https://www.materialsperformance.com/articles/coating-linings/2018/02/new-rotor-blade-inspection-methods-for-offshore-wind-turbines [https://perma.cc/68R4-KEZ7] (exploring the use of drone and mobile thermography technology to potentially increase the lifespan of wind turbines).

208. Walters, *supra* note 207, at 1; *see also Inspecting Rotor Blades with Thermography and Acoustic Monitoring*, FRAUNHOFER-GESELLSCHAFT (Dec. 1, 2017), https://www.fraunhofer.de/en/press/research-news/2017/december/inspecting-rotor-blades-with-thermography-and-acoustic-monitoring.html [https://perma.cc/R8XD-R36G] (explaining the increased complexities with maintaining offshore wind turbines due to harsh weather conditions that prevent regular maintenance).

209. Interview with Steve Drouilhet, Founder & CEO, Sustainable Power Systems, Boulder, Colorado (Apr. 29, 2016) (reporting that fatigue after 6 months of operation can result in blades detaching from the nacelle hub or other failures).

Early U.S. wind farm developers did not fully appreciate turbine wake dynamics.[210] For example, a project started in 1989 at the San Gorgonio Pass in Southern California spaced almost 1,000 turbines in forty-one closely spaced rows.[211] This tight spacing caused the turbines to experience premature fatigue, frequent failures, and significant damage to the components.[212] With new insights, developers now model waking at the project layout stage.[213] If this modeling suggests that a turbine is located too closely to another, this may compromise the warranty from the turbine manufacturer.[214]

Wind turbines continue to increase in capacity and size.[215] Currently, the largest offshore wind turbine in the world is fourteen megawatt with an RD of twenty-two meters.[216] Spacing two of these turbines at five RD to avoid damaging each other would mean that they should be over one kilometer, or approaching three-quarters of a mile, apart.[217]

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210. DuVivier & Mooney, *supra* note 207, at 22; *see id.* at 2 n.11 (explaining the terminology "wind farm" or "farm" when used in context, is interchangeable with "wind plant" or "wind power project").

211. Neil D. Kelley, Nat'l Wind Tech. Ctr., Boundary Layer Turbulence and Turbine Interactions with a Historical Perspective at AMS Short Course, at 18–19 (Aug. 1, 2010); *see also* Neil D. Kelley et al., *Using Wavelet Analysis to Assess Turbulence-Rotor Interactions*, 3 WIND ENERGY 121, 129–34 (2000) (expressing the importance of adequate wind flow to maintain reduced fatigue damage in turbines).

212. Kelly et al., *supra* note 211, at 133.

213. DuVivier & Mooney, *supra* note 207, at 11.

214. *See, e.g.*, Waveney Dist. Council v. Next Generation Ltd. [2003] P.A.D. 36, 344, 352 [5.4] (Eng.) ("Correspondence from the turbine supplier (Enron Wind, now GE Wind Energy) indicates that an absolute minimum spacing of 300m is required between turbines in order to validate warranty conditions.").

215. *See* John Parnell, *Siemens Gamesa Launches 14MW Offshore Wind Turbine, World's Largest*, GREENTECH MEDIA (May 19, 2020), https://www.greentechmedia.com/articles/read/siemens-gamesa-takes-worlds-largest-turbine-title [https://perma.cc/656V-U5JM] (explaining that turbines keep getting bigger, but financial limitations may ultimately halt the development of developing even larger turbines).

216. *Id.* The turbine blades and hub form the rotor portion of a wind turbine and are attached to the nacelle, which contains the electricity generation equipment, on the tower. Rotor diameters are a standard measurement in wind development and are roughly equivalent to the length of two turbine blades. At time of publication, the GE Haliade-X is the largest commercially available wind turbine in the world. However, the upcoming Siemens Gamesa 14-222 DD model, at fourteen megawatt and an RD of 222 meters, is slightly larger. *Id.*

217. See Dillon Clayton, *Wind Turbine Spacing: How Far Apart Should they Be?*, ENERGY FOLLOWER (July 20, 2021), https://energyfollower.com/wind-turbine-spacing [https://perma.cc/2L36-LCRV] (explaining that wind turbines should be spaced apart seven times the distance of their rotor diameter). The Siemens Gamesa 14-222 DD has an RD of 222 meters (or equivalent to about 728 feet per RD), then there

This spacing is necessary to avoid premature fatigue and equipment damage to the turbines.

### *B. Energy Loss*

The goal of a wind farm is to extract energy from wind to generate electricity. The loss of energy when an upwind farm diminishes the flow to downwind farms can be an even more costly impact of wakes in comparison to equipment damage.[218] Onshore wind energy development in the United States has been a cutthroat business—highly competitive and secretive.[219] Developers have not openly shared specifics about upwind projects cannibalizing downwind productivity, but public data about electricity production along with atmospheric and economic modeling provided the basis for a 2018 *Nature Energy* article about the scope of wake impacts.[220] The article studied three wind farms in West Texas—one predominantly upwind ("Loraine"), one predominantly downwind ("Roscoe"), and one "control" ("Champion").[221] Because the upwind farm was built after both the downwind and control, it was possible to measure the impact of the energy loss on the downwind farm resulting from the construction of the upwind farm.[222] The upwind farm's wakes caused significant decreases in the amount of electricity generated by the downwind farm resulting in a loss of revenue of up to $730,000 in lost sales and $2 million in lost production tax credits *annually*.[223] In addition, the value of the fossil-fuel generated power that the wind farm displaced over

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would still be a turbulence impact at five RDs or 3640 feet. William Mathis, *Battle Over World's Biggest Turbine Is Heating Up*, BLOOMBERG NEWS (May 19, 2020), https://financialpost.com/pmn/business-pmn/battle-over-worlds-biggest-wind-turbine-is-heating-up [https://perma.cc/7U2X-QADL].

218. K.K. DuVivier, *Wind Power Growing Pains*, 21 CHAPMAN NEXUS J.L. & POL'Y 1, 9 (2016); *see also* DuVivier & Mooney, *supra* note 207, at 10–11 (explaining the losses from downwind wake loss "can be in the millions of dollars or more annually").

219. DuVivier, *supra* note 218, at 9; *see also* DuVivier & Mooney, *supra* note 207, at 18–20 (explaining that because developers wish to prioritize profits, they will often not accurately space turbines causing energy and money loss to neighboring plants).

220. *See* Lundquist et al., *supra* note 206, at 26 (analyzing the impact of the 2008–2009 construction of the Loraine wind project on the existing Roscoe project in Texas).

221. *Id.*

222. *Id.* at 31.

223. *Id.* at 28.

the study period represented an additional $4.1 million based on a social cost of carbon of $37 per ton.[224]

Most onshore U.S. wind farms appear to be in locations where they are, or could be, vulnerable to wakes.[225] Additionally, the scientific community continues to research the extent of energy loss impacts offshore.[226] Early studies off the coast of Denmark show wake trails that propagate for 20 kilometers (or about 12.5 miles) before near-neutral conditions are reached.[227] While some have used a ten RD rule of thumb for full wake protection, other studies have tracked wakes for more than seventeen kilometers.[228] In addition, some models have even shown a reduction of ten percent between wind farms sixty kilometers (thirty-five miles) away.[229]

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224. *Id.*

225. *See* K.K. DuVivier & Mooney, *supra* note 207, at 26 n.158 (explaining a review of the 2019 U.S. Wind turbine database website revealed that almost twenty-two percent of U.S. onshore wind farms are within five RD of a turbine in an adjacent farm, and almost thirty-eight percent are within ten RD).

226. *See, e.g.*, Pedro A. Jiménez et al., *Mesoscale Modeling of Offshore Wind Turbine Wakes at the Wind Farm Resolving Scale: AA Composite-Based Analysis with the Weather Research and Forecasting Model Over Horns Rev*, 18 WIND ENERGY 559, 559 (2015) (using mesoscale modeling to study offshore wind turbine wakes); *see also* Clara M. St. Martin et al., *Wind Turbine Power Production and Annual Energy Production Depend on Atmospheric Stability and Turbulence*, 1 WIND ENERGY SCI. 221, 221 (2016) (studying power curves and energy production on a wind turbine); Nicolai Gayle Nygaard & Sidse Damgaard Hansen, *Wake Effects Between Two Neighbouring Wind Farms*, 753 J.PHYSICS: CONF. SERIES 1, 9–10 (2016) (comparing two offshore wind farms to better understand "wind farm clusters"); Nicolai Gayle Nygaard, *Wakes in Very Large Wind Farms and the Effect of Neighbouring Wind Farms*, 524 J. PHYSICS: CONF. SERIES 1, 1–2 (2014) (studying three wind farms to analyze wakes and energy loss).

227. Merete Bruun Christiansen & Charlotte B. Hasager, *Wake Effects of Large Offshore Wind Farms Identified from Satellite SAR*, 98 REMOTE SENSING ENV'T 251, 252, 266 (2005); *see* Charlotte B. Hasager et al., *Using Satellite SAR to Characterize the Wind Flow around Offshore Wind Farms*, 8 ENERGIES 5413, 5413 (2015) (analyzing Synthetic Aperture Radar at various wind farm clusters and determining Denmark's Horns Rev two as being the strongest)); *see also* Nygaard *supra* note 226, at 8–10 (explaining research about the impact of the Rødsand II wind project on the efficiency of the Nysted project in the North Sea, which showed turbine efficiency dropped by twenty-one percent).

228. Nicolai Gayle Nygaard & Alexander Christian Newcombe, *Wake Behind an Offshore Wind Farm Observed with Dual-Doppler Radars*, 1037 J. PHYSICS: CONF. SERIES 1, 4 (2018).

229. Anna C. Fitch et al., *Mesoscale Influences of Wind Farms Throughout a Diurnal Cycle*, 141 MONTHLY WEATHER REV. 2173, 2182 (2013). Wakes from wind plants over the sea are expected to extend further downwind than those over land, especially under a more stable flow, which inhibits thermally produced turbulence. Martin Dörenkämper

### *C. Current Solution to Wind Waste: Moats*

U.S. wind law appears to follow the same rule of capture that prevails in oil and gas development.[230] Yet, in contrast to oil and gas, the property status of wind rights in the United States is uncertain and has been debated for over a century.[231] In most other countries in the

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et al., *On the Offshore Advection of Boundary-Layer Structures and the Influence on Offshore Wind Conditions*, 155 BOUNDARY LAYER METEOROLOGY 459, 460 (2015); *see also* Mark A. Harral et al., *The Wake Effect: Impacting Turbine Siting Agreements*, N. AM. CLEAN ENERGY (Jan. 20, 2013), https://web.archive.org/web/20210115205437/http://www.nacleanenergy.com/articles/15348/the-wake-effect-impacting-turbine-siting-agreements (citing Brian D. Hirth & John L. Schroeder, *Documenting Wind Speed and Power Deficits Behind a Utility-Scale Wind Turbine*, 52 J. APPLIED METEOROLOGY & CLIMATOLOGY 39 (2013)).

230. *See, e.g.*, Romero v. Bernell, 603 F. Supp. 2d 1333, 1335 (D.N.M. 2009) (stating that wind should be treated "like water or wild animals which traverse the surface and which do not belong to the fee owner until reduced to possession"); *see also* Contra Costa Water Dist. v. Vaquero Farms, Inc., 68 Cal. Rptr. 2d 272, 278 (Ct. App. 1997) ("[T]he right to generate electricity from windmills harnessing the wind, and the right to sell the power so generated, is no different, either in law or common sense, from the right to pump and sell subsurface oil, or subsurface natural gas by means of wells and pumps."); Terry E. Hogwood, *Against the Wind*, 26 OIL, GAS & ENERGY RES. L. SEC. REP. 6, 6–7 (State Bar of Tex. 2001); Ernest Smith, *Wind Energy: Siting Controversies and Rights in Wind*, 1 ENV'T & ENERGY L. & POL'Y J. 281, 301 (2007) (citing Hogwood to say wind ownership may be comparable to the "capture" theory used for wild animals or the law of percolating water).

231. *See, e.g.*, Kimberly E. Diamond, *Wake Effects, Wind Rights, and Wind Turbines: Why Science, Constitutional Rights, and Public Policy Issues Play a Crucial Role*, 40 WM. & MARY ENV'T L. & POL'Y REV. 813, 822 (2016); Yael Lifshitz, *Rethinking Original Ownership*, 66 U. TORONTO L.J. 513, 514 (2016); Yael Lifshitz, Note, *Winds of Change: Drawing on Water Law Doctrines to Establish Wind Law*, 23 N.Y.U. ENV'T L.J. 434, 437 (2015); RULE, CONFLICTS, *supra* note 206, at 50; Diamond & Crivella, *supra* note 206, at 204; 204; K.K. DuVivier, *Sins of the Father*, 1 TEX. A&M J. REAL PROP. L. 391, 412 (2014) [hereinafter DuVivier, *Sins*]; Ernest E. Smith & Becky Diffen, *Winds of Change: The Creation of Wind Law*, 5 TEX. J. OIL GAS & ENERGY L. 165, 166 (2009–2010); Troy Rule, *Sharing the Wind*, 27 ENV'T F. 30 (2010); Yael Lifshitz-Goldberg, Comment, *Gone with the Wind? The Potential Tragedy of the Common Wind*, 28 UCLA J. ENV'T L. & POL'Y 435, 436 (2010); K.K. DuVivier, *Animal, Vegetable, Mineral—Wind? The Severed Wind Power Rights Conundrum*, 49 WASHBURN L.J. 69, 69 (2009) [hereinafter DuVivier, *Wind Power Rights*]; K.K. DuVivier & Roderick E. Wetsel, *Jousting at Windmills: When Wind Power Development Collides with Oil, Gas, and Mineral Development*, 55 ROCKY MTN. MIN. L. INST. 9-1, 9-4 (2009); Lisa Chavarria, *The Severance of Wind Rights in Texas*, STAHL, BERNAL & DAVIES L.L.P. 1, 1, https://www.sbaustinlaw.com/library-papers/Chavarria-The_Severance_of_Wind_Rights%20(Final).pdf [https://perma.cc/7C86-MQ8A]; Lisa Chavarria, *Wind Power Prospective: Issues*, 68 TEX. B.J. 832, 835 (2005) (stating that Chavarria does not support or oppose the practice of severance but recognizes that it is common among Texas landowners); Hogwood, *supra* 230; Smith, *supra* 230, at 301 ("Wind does

world, natural resources—including minerals and wind—are owned by the state.[232] In the United States, wind sometimes appears to be privately owned when associated with private lands, but the nature of that ownership is unclear.[233] In the absence of a legal structure that provides compensation for losses or incentives for inter-developer cooperation, onshore wind farm developers in the United States have modeled their turbine layouts to maximize production from the properties they control regardless of the impact upon neighboring projects.[234]

In addition, to counter the aggression of neighboring developers under this catch-as-catch can, each-for-themselves legal structure, onshore wind developers have resorted to creating moats or buffer zones around many of their projects as a protective measure for themselves.[235] The United Kingdom, which is the world leader in offshore wind development, has codified these defensive moats in its

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not share the physical characteristics of solid minerals or of water. It can hardly be deemed part of the fee simple or owned 'in place' by a landowner."). Smith also cites Hogwood to say wind ownership may be comparable to the "capture" theory used for wild animals or the law of percolating water and Contra Costa for noting that states may alternatively "look to oil and gas law for an analogy." *Id.* at 300–01; Joseph O. Wilson, Note, *The Answer, My Friends, Is in the Wind Rights Contract Act: Proposed Legislation Governing Wind Rights Contracts*, 89 IOWA L. REV. 1775, 1784 (2004); Choctaw, O. & T. R.R Co. v. True, 80 S.W. 120, 121 (Tex. Civ. App. 1904). For other valuable articles addressing wind rights, without as much emphasis on the categorization of the right, see Helle Tegner Anker et al., *Wind Energy and the Law: A Comparative Analysis*, 27 J. ENERGY & NAT. RES. L. 145, 146 (2009); Elizabeth Burleson, *Wind Power, National Security, and Sound Energy Policy*, 17 PENN ST. ENV'T L. REV. 137, 138 (2009); Bent Ole Gram Mortensen, *International Experiences of Wind Energy*, 2 ENV'T & ENERGY L. & POL'Y J. 179, 209 (2008); K. Shawn Smallwood, *Wind Power Company Compliance with Mitigation Plans in the Altamont Pass Wind Resource Area*, 2 ENV'T & ENERGY L. & POL'Y J. 229, 233 (2008); Roderick E. Wetsel & H. Alan Carmichael, Current Issues in Wind Energy Law 2009 at the State Bar of Texas 20th Annual Advanced Real Estate Drafting Course (Mar. 5–6, 2009); Ernest E. Smith, Roderick E. Wetsel, Becky H. Diffen, & Melissa Powers, WIND LAW § 4.01 (LexisNexis 2020).

232. *See, e.g.*, Marc Howe, *Chinese Regional Government Claims Wind Energy Is "State-Owned"*, WINDPOWER MONTHLY (June 19, 2012), https://www.windpowermonthly.com/article/1136930 [https://perma.cc/WG3U-A5LR] (explaining Article 9 of China's constitution was interpreted to mean that wind and solar energy are state-owned resources).

233. *See, e.g.*, DuVivier, *Sins*, *supra* note 231, at 412 (explaining that there is not a firm legal standard as to if private property also includes the wind of that property).

234. DuVivier & Mooney, *supra* note 207, at 19.

235. *Id.* at 22.

wind regulations.[236] Offshore leasing in the United Kingdom is regulated by the Crown Estate, which is an independent commercial business created by an Act of Parliament to manage the development of wind, as well as minerals, cables, and pipelines in the seabed around England, Wales, and Northern Ireland.[237] The Crown Estate requires five-kilometer setbacks for all of its leases, resulting in up to ten kilometers of undeveloped area between adjacent leases.[238] A handful of U.S. offshore leases now also have a similar, albeit smaller, designated setback.[239]

The problem with the moat solution is two-fold. First, it leaves undeveloped large areas that potentially could otherwise be productive for wind energy development.[240] Consequently, these moats do not economically or efficiently utilize the wind resource. Second, it is underinclusive as some turbines have negative impacts that extend beyond the distances set.[241] These issues will only continue to be

236. *Id.* at 32, 45.

237. *Introducing Offshore Wind Leasing Round 4*, THE CROWN ESTATE (Sept. 2019), 2019), https://www.thecrownestate.co.uk/media/3321/tce-r4-information-memorandum.pdf [https://perma.cc/672W-X2U2]; *see also* THE CROWN ESTATE, OFFSHORE WIND NEW LEASING MARKET ENGAGEMENT EVENT 10 (2018), https://www.thecrownestate.co.uk/media/2797/20181126-new-leasing-engagement-event-slides-published.pdf [https://perma.cc/QC33-QV33].

238. E-mail from Ben Barton, Senior Com. Manager for the Crown Est., to Karina Condra, Reference Libr., U. Denv. July (July 12, 2019); *see* The Crown Est., Offshore Wind New Leasing at the OSW Market Engagement Event (Nov. 26, 2018). 26, 2018). The latest U.K. developments in the new Round 4 tender process are now required to have a 7.5 kilometer buffer unless an existing project provides its consent for a closer proximity. Memorandum from The Crown Est. on Introducing Offshore Wind Leasing Round 4 (Sept. 2019), https://www.thecrownestate.co.uk/media/3321/tce-r4-information-memorandum.pdf; *see* E-mail from Ben Barton, Senior Com. Manager for the Crown Est., to Karina Condra, Reference Libr., U. Denver (Mar. 2, 2021) (on file with author).

239. *See, e.g.*, U.S. Dep't of the Interior, *Commercial Lease of Submerged Lands for Renewable Energy Development on the Continental Shelf*, OCEAN ENERGY MGMT. BUREAU, at C-17 add. C (2019), https://www.boem.gov/sites/default/files/renewable-energy-program/State-Activities/MA/Lease-OCS-A-0520.pdf [https://perma.cc/L8HA-2AE5] ("In its COP project design, the Lessee must incorporate a 750 m setback from any shared lease boundary within which the Lessee may not construct any surface structures, unless the Lessee and the adjacent lessee agree to a smaller setback, the Lessee submits such agreement to BOEM, and BOEM approves it.").

240. *See, e.g.*, RULE, CONFLICTS, *supra* note 206, at 50–51 (describing, with illustrations and economics, a waivable setback proposal).

241. *See* DuVivier & Mooney, *supra* note 207 at 19, 26 &n.158 (explaining wakes can have significant impacts up to sixty kilometers away; standard setbacks are only five to ten RD).

problematic as the United States increasingly invests in wind development projects.

### *D. Better Solution to Wind Waste: Cooperative Development*

Wind energy has never had the luxury of a legal regime created to address its unique attributes. Instead, it has been wrested into regimes established to meet other needs or resources.[242] For example, Congress passed the Federal Land Policy and Management Act[243] (FLPMA) in 1976, before current wind energy technologies. To accommodate wind power development in the 1980s, federal officials employed FLPMA right-of-way authority for permitting onshore wind energy projects.[244] Generally, the FLPMA authority had previously been used for linear developments such as transmission lines, not for fields of resource development like wind.[245]

Offshore wind faced even more hurdles than onshore due to a lack of clear statutory authority to allow development. Federal officials' hands were tied without statutory permission, comparable to the FLPMA right-of-way for federal lands, to issue permits or leases for wind energy projects in federal waters.[246] The OCS Lands Act,[247] passed in 1953, authorized the Secretary of the Interior to grant any oil, gas, or mineral leases on submerged lands of the outer continental shelf.[248] Yet, there was nothing that permitted wind energy projects until the Energy Policy Act of 2005[249] updated some of the provisions of the Energy Policy Act of 1992[250] to address wind energy production.[251] The

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242. *See, e.g.*, DuVivier, *Sins*, *supra* note 231, at 411 (examining the parallels between oil and gas severance compared to the wind industry).

243. Federal Land Policy and Management Act of 1976, Pub. L. No. 94-579, 90 Stat. 2744.

244. David J. Lazerwitz, *Renewable Energy Development on the Federal Public Lands: Catching Up with the New Land Rush*, 55 ROCKY MTN. MIN. L. INST. 13-1, 13-8 (2009).

245. *See id.* at 13-7 (discussing how the FPLMA has "historically focused on providing noncompetitive 'rights-of-way' . . . for roads, pipelines, and transmission").

246. 43 U.S.C. § 1761(a) (2018).

247. Outer Continental Shelf Lands Act of 1953, Pub. L. No. 83-212, 67 Stat. 462 (1953).

248. *Id.* § 4(a)(1).

249. Energy Policy Act of 2005, Pub. L. No. 109-58, 119 Stat. 594 (2005).

250. Energy Policy Act of 1992, Pub. L. No. 102-486, 106 Stat. 2776 (1992).

251. Section 388(a) of 2005 Energy Policy Act amended Section 8 of the Outer Continental Shelf Lands Act to authorize the Secretary of the Interior to lease submerged lands "[in] support [of] production, transportation, or transmission of

Secretary of the Interior subsequently delegated the authority to regulate offshore wind activities to the Bureau of Ocean Management (BOEM) and the Bureau of Safety and Environmental Enforcement (BSEE).[252]

The lack of a statutory regime specifically for onshore wind may have contributed to its slow uptake on federal lands: as of early 2019, federal lands represented about five percent of all U.S. wind energy capacity onshore.[253] However, the current statutory structure for offshore wind may provide a vehicle for maximizing offshore wind development without having to address the pesky wind ownership issue and allowing offshore development to fall into the wasteful competitive and protective production patterns that characterize much current onshore wind.[254]

As noted above, in the oil and gas context, the OCS Lands Act promotes both correlative rights and conservation of all-natural

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energy *from sources other than oil and gas*." *Id.* § 388(a)) (codified as amended at 43 U.S.C. § 1337(p)(1) (C) (2005)) (emphasis added).

252. Originally, the Secretary delegated the leasing and management authority to the Minerals Management Service (MMS), which at that time also administered the OCS oil and gas leasing process. However, the federal government grew concerned that MMS, which controlled both leasing and safety as well as revenue generation, had a conflict of interest that may have contributed to the Macondo Well blowout from the Deepwater Horizon oil rig in April 2010. So, the BLM reorganized MMS to separate the two functions. The Office of Natural Resources Revenue controls royalty payments. A new agency, the Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE) was created to control leasing and safety. BOEMRE was further divided into the Bureau of Ocean Energy Management and the Bureau of Safety and Environmental Enforcement (BSEE). HENRY B. HOGUE, CONG. RESEARCH SERV., R41485, REORGANIZATION OF THE MINERALS MANAGEMENT SERVICE IN THE AFTERMATH OF THE DEEPWATER HORIZON OIL SPILL 1–14 (2010); *see also* Secretarial Order 3071 (Jan. 19, 1982) (codified at 30 C.F.R. § 1201 (1982)) (giving MMS authority over offshore leasing); 30 C.F.R. § 585.100 (2019); Memorandum of Understanding between the U.S. Dep't of the Interior and Fed. Energy Reg. Commission (Apr. 9, 2009), https://www.boem.gov/Renewable-Energy-Program/DOI_FERC_MOU.aspx [https://perma.cc/ZG87-6GBZ] (FERC permits marine hydrokinetic (wave and tidal) through its license process, while BOEM issues leases if they are on the OCS. BOEM has exclusive jurisdiction for leasing and permitting wind on the OCS).

253. BUREAU OF LAND MGMT., WIND ENERGY, https://www.blm.gov/programs/energy-and-minerals/renewable-energy/wind-energy [https://perma.cc/E2TY-KTJ2]. Other factors have contributed, such as the lack of clear agency policies and NEPA requirements. *See, e.g.*, Lazerwitz, *supra* note 244, at 13-6, 13-7; Irma S. Russell, *Streamlining NEPA to Combat Global Climate Change: Heresy or Necessity?*, 39 ENVT'L L. 1049, 1051 (2009).

254. *See supra* notes 8, 244–49 and accompanying text.

resources, not just the mineral resources.[255] By granting wind leases, the government is granting each lessee a right to harvest a valuable interest in the wind's energy.[256] Through its regulations and management, the federal government has found a balance between protecting the correlative rights of its lessees while also maximizing development of its offshore oil and gas resources.[257] As discussed in this Section, this balance can be achieved primarily by the federal government's use of regulations and unitization-like approaches to maximize the development of American off-shore wind resources. This Section addresses how the federal government can use comparable regulations and unitization-like approaches to maximize development of U.S. offshore wind resources.[258]

The federal regulatory definition of "waste" in the OCS Lands Act only addresses oil, gas, and sulphur—not wind.[259] However, the government must ensure that offshore wind leasing and development are carried out in a manner that provides for, inter alia, "(C) [the] prevention of waste [and] . . . (G) [the] protection of correlative rights in the outer Continental Shelf."[260] Although many judges eschew legislative history, section § 1337(p)(4) was first proposed as the "Alternative Energy-Related Uses on the Outer Continental Shelf" amendment to the 2005 Energy Policy Act.[261] The current list of required considerations was not in the original bill and appears to have been gleaned from proposed legislation that the Department of the Interior had suggested years before.[262] With respect to waste and correlative rights, the factors enacted closely mirror the offshore oil

255. *See supra* notes 154–92 and accompanying text.

256. *See* Elizabeth Weise, *Wind Energy gives American Farmers a New Crop to Sell in Tough Times*, USA TODAY (Feb. 16, 2020), https://www.usatoday.com/story/news/nation/2020/02/16/wind-energy-can-help-american-farmers-earn-money-avoid-bankruptcy/4695670002 [https://perma.cc/LEJ8-ZK3X].

257. *See supra* notes 115–27 and accompanying text.

258. Yael R. Lifshitz, *The Geometry of Property*, 71 UNIV. TORONTO L.J., 480 (2021). Using a broader definition of unitization in the wind context: "[T]he important point is that unitization essentially aggregates entitlements from multiple vertical right-holders into a unified horizontal regime. It overcomes the spatial misalignment in that sense. Applying this notion to wind would entail setting up a mechanism for pooling the rights of multiple landowners into a unified management of wind over a given area." *Id.* at 36–37.

259. *See supra* notes 156–57 and accompanying text.

260. 43 U.S.C. § 1337(p)(4) (2018).

261. Pub. L. No. 109-58, sec. 388, 119 Stat. 594, 744 (2005)).

262. *See, e.g.*, 151 Cong. Rec. S6834, S6865 (2005).

and gas provisions of 43 U.S.C. 1334(a).[263] Therefore, while the same word may have different meanings in different contexts, this analysis will apply federal oil and gas waste law to wind energy development and suggest a possible addition to 30 C.F.R. to ensure that the nascent U.S. offshore wind industry grows in a collaborative, rather than a wasteful way.[264]

The above discussion of waste as defined by the federal oil and gas regulation focused on four elements: (1) "dissipation of reservoir energy"; (2) "reduction in the quantity of resource ultimately recoverable"; (3) "production in excess of reasonable market demand"; and (4) "drilling of unnecessary wells."[265] Item one of this list—dissipation of reservoir energy—is unique to how oil and gas reservoirs are developed. Consequently, it has no application in the context of wind energy development. Similarly, item three on this list—production in excess of reasonable market demand—primarily addresses private financial interests. The current federal regulation for oil and gas does not include it, and there is no reason for wind energy development to include it either.

Therefore, this Section will address the remaining two elements of waste in the above list: (1) reduction in the quantity of resource ultimately recoverable and (2) the wind development equivalent of drilling unnecessary wells—building unnecessary infrastructure. In addition, this discussion will show that concerns about item (1) indicate too few turbines may be constructed, and item (2) indicates that there may be situations when, ironically, too many have been erected and are no longer performing to their capacity because of adjacent development.

*1. Reduction in the quantity of resource ultimately recoverable*

Section II.A.2 above addressed ways in which oil and gas resources have been rendered unrecoverable by the development practices of one operator or another. Lessors, specifically the U.S. government in the context of offshore oil and gas development, have several

263. *Id.*

264. United States *ex rel.* Chi., N.Y. & Boston Refrigerator Co. v. Interstate Com. Comm'n, 265 U.S. 292, 295 (1924) ("[B]ecause words used in one statute have a particular meaning they do not necessarily denote an identical meaning when used in another and different statute.").

265. *Supra* notes 153–62 and accompanying text (analyzing 30 C.F.R. §§ 250.105, 550.105).

incentives for maximizing recovery of these resources.[266] First, assuming their development benefits society, then the more that is recovered, the greater the benefit.[267] Second, the United States receives royalties based on the amount of resource recovered, so maximizing recovery also maximizes this royalty-payment benefit for the American people.[268]

One of the primary ways that the U.S. government has ensured maximization of the quantity of oil and gas recovered from its offshore leases is through cooperative agreements or unitization.[269] Cooperative development of oil and gas resources has resulted in the most efficient and economical development and dramatically improved recovery rates.[270] Consequently, Congress granted U.S. regulatory agencies the authority to mandate that separate lessees enter agreements to develop their offshore interests cooperatively.[271]

Energy recovery of U.S. offshore wind resources would also be maximized by allowing regulatory agencies to mandate cooperative development and to control turbine locations.[272] As explained in

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266. *See supra* notes 40–52, 66–73 and accompanying text.

267. U.S. Dep't of Energy, *Quadrennial Technology Review 2015: Oil and Gas Technologies, Chapter 7: Advancing Systems and Technologies to Produce Cleaner Fuels*, 1 (2015).

268. Waste Prevention, Production Subject to Royalties, and Resource Conservation, 81 Fed. Reg. 83,008, 83,041 (Nov. 18, 2016) (to be codified at 43 C.F.R. § 3103.3-1).

269. *See supra* Section II.A.2 (discussing cooperative agreements and unitization).

270. *See supra* notes 121–24 and accompanying text.

271. 43 U.S.C. § 1334(j)(2).

272. For many wind developers, the ultimate goal is to maximize profits, and this goal may align with maximizing recovery, i.e., the number of gigawatt hours a wind plant produces, but there may be other factors that come into play such as costs for bonus payments, rents, royalties, cable construction, cable losses, the expenses to install each turbine (purchase price, deep borings, foundation, installation), production per turbine, site investigation costs, and operation and maintenance. Developers face a fundamental dilemma when planning the layout of their wind farms to maximize production and minimize losses. Because more turbines mean more opportunities to generate electricity, developers might be tempted to site many turbines with closer spacing. Yet, waking between turbines that are too closely spaced can reduce the average production of each turbine and create more equipment damage, with its related costs. Modeling will be needed to help developers determine the best tradeoffs within a development area to avoid underperformance due to waking, which in some cases has been up to forty percent, representing a lot of lost energy and high costs for the industry. David Glickson, *High-Tech Tools Tackle Wind Farm Performance*, NAT'L RENEWABLE ENERGY LAB'Y (Sept. 20, 2012), https://www.nrel.gov/news/features/2012/1995.html [https://perma.cc/6L3V-MJBU];

Section IV.A above, neighboring U.S. onshore wind farms have impacted one another by damaging nearby equipment and "stealing" from downwind farms recoverable energy that could have been converted to electricity.[273] The lack of regulation from governmental agencies and absence of a clear property rights regime to address the problem have incentivized many developers to create protective "moats" of turbine-free swaths of lands around their projects that could otherwise have been used to exploit the available energy in the wind and convert it to electricity.[274]

To avoid this waste, the United States, as the lessor, should create a cooperative development system. Such a system would not exactly follow the unitization mechanisms used for oil and gas development because wind is not contained in geologic traps similar to those defining conventional oil and gas deposits. However, ocean wind currents are generally more predictable than land currents, and modeling could define expected patterns and potential optimal turbine layout patterns.[275]

In U.S. offshore oil and gas operations, the federal government will often stop short of a full unitization order, which would require the parties to have a single operator and share all decision-making, costs, and revenues.[276] Instead, wind regulations could borrow from oil and gas requiring lessees to share early development plans with adjacent developers, and the federal government could review and approve turbine layouts. As with oil and gas, a key component would be

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MATTHEW J. CHURCHFIELD ET AL., A LARGE-EDDY SIMULATION OF WIND-PLANT AERODYNAMICS 2 (2012), https://www.nrel.gov/docs/fy12osti/53554.pdf [https://perma.cc/UE8E-MQ24].

273. *See supra* Section III.C. Without legal recourse for lost revenue or incentives for collaborative planning with neighboring wind farms, developers are faced with a "tragedy of the commons" type dilemma and are incentivized to maximize their own gains at the expense of downwind farms.

274. *See* DuVivier & Mooney, *supra* note 207, at 2.

275. *See* W. MUSIAL ET AL., NAT'L RENEWABLE ENERGY LAB'Y, ASSESSMENT OF OFFSHORE WIND ENERGY LEASING AREAS FOR THE BOEM MASSACHUSETTS WIND ENERGY AREA, , 1, 12 (2013), https://www.nrel.gov/docs/fy14osti/60942.pdf [https://perma.cc/42ST-LHCG]. *But cf. id.* at 23 (observing that while many offshore sites have prevailing winds in one direction, the mid-Atlantic states experience "more bimodal [offshore] wind direction distributions" resulting in "projects [that] may experience relatively higher wake losses and more difficultly in optimizing array layouts for power production.").

276. *See* Dana E. Dupre, *What Makes the United States Offshore Leasing System So Special? A Primer on the Outer Continental Shelf Oil and Gas Lease*, 4 LSU J. ENERGY L. RESOURCES 37, 49–50 (2015).

recognizing the correlative rights of all owners in the unit and allocating each a share of revenues for production even if a turbine is not located on a particular owner's lease.[277]

Although requiring cooperation for turbine locations up to and across lease boundaries might maximize recovery, an alternative approach might increase recovery in situations where the lease agreements require setbacks or moats around lease boundaries as in the U.K. Crown leases and some U.S. leases.[278] While some of these setbacks are waivable, the default is no development in these setback areas, resulting in no electricity generation from this acreage.[279] In contrast, the federal government might retain the setbacks but create a system of notifying adjacent leaseholders of potential development in a setback area. Then the downwind developer might construct a turbine there and exercise an option to pay the upwind developer for the expected loss of electricity generation from a turbine on the upwind lease.[280] Yet another option might be to share costs and revenues from turbines in the buffer zones rather than sharing with the entire acreage of the leases.

A second consideration in determining the "quantity of resource ultimately recoverable" is that the federal regulation includes a "prudent operator" standard.[281] Interestingly, so far in the nascent U.S. offshore wind-leasing context, this has played out to reduce the number of turbines that might be installed without any compensation for losses that might otherwise be considered waste.[282] Specifically, when wind developers in Rhode Island and Massachusetts first submitted plans to BOEM, they proposed a spacing of 0.7 miles for

277. As wind collection technologies evolve from turbines to kite-like mechanisms, it may be more important than ever for the government to think in terms of a horizontal regime for extracting the airborne kinetic energy instead of adhering to a vertical, lease by lease vertical regime based on the infrastructure used to collect this resource. *See generally* Yael R. Lifshitz, *The Geometry of Property*, UNIV. TORONTO L.J., 1, 3–7 (Forthcoming).

278. *See supra* Section IV.C.

279. *See* DuVivier & Mooney, *supra* note 207, at 28.

280. *See* DuVivier, *supra* note 230, at 26–28. Rather than drilling an offset well, neighboring oil and gas operators sometimes agree to compensatory royalties when a well is drilled on adjacent acreage. *See* Troy A. Rule, *Airspace in a Green Economy*, 59 UCLA L. REV. 270, 305–06 (2011) (describing the economics of a sample waivable wake setback).

281. *See supra* notes 125–26 and accompanying text.

282. *See infra* notes 283–85 and accompanying text.

their turbines to optimize electricity production from their leases.[283] However, to address concerns of the fishing industry, these developers agreed instead to space their turbines one mile apart.[284] This compromise sacrificed thirty percent of the energy production, or up to twelve gigawatts of electricity that could have been produced. This compromise also may have inadvertently created a new industry standard, suggesting that a prudent operator not facing the same pressure to compromise would choose to develop at a less-dense spacing than necessary to maximize recovery.[285]

One reason the 2016 Waste Prevention Rules were vacated was that a federal judge in Wyoming was concerned with detrimental reliance by oil and gas operators when "an agency's new policy 'rests upon factual findings that contradict those which underlay its prior policy.'"[286] No such reliance is a factor in the context of offshore wind as the industry is in its infancy. It is a "new policy created on a blank slate," and BOEM reasonably should recognize that such spacing compromises represent waste of the full resource. Noise[287] and operational restrictions to mitigate impacts on protected species[288] will also likely prevent full development of the wind energy resource. Consequently, while BOEM recognizes its analysis creates "significant reductions in the[] resulting area available for offshore wind development" and "does not maximize the potential wind energy produced,"[289] it does not yet calculate the monetary value of the wind

283. BUREAU OF OCEAN ENERGY MGMT., TRANSCRIPT OF VINEYARD WIND SEIS PUBLIC MEETING DAY 2, 1, 100–01 (June 30, 2020), https://www.boem.gov/sites/default/files/documents/renewable-energy/Vineyard%20Wind%20SEIS%20Pub.%20Mtg.%20Day%202.pdf [https://perma.cc/HM6T-AX3C] (Testimony of Ian Clayton).

284. Letter from Equinor Wind, Eversource Energy, Mayflower Wing, Orsted North America, and Vineyard Wind to Michael Emerson, U.S. Coast Guard (Nov. 1, 2019), *in* 3 DRAFT CONSTRUCTION AND OPERATIONS PLAN, app. III-P (2020).

285. *See supra* note 283.

286. Wyoming v. U.S. Dep't of the Interior, 493 F. Supp. 3d 1046, 1084 (D. Wyo. 2020) (quoting FCC v. Fox Television Stations, Inc., 556 U.S. 502, 515 (2009)).

287. Whales are sensitive to noise, so restrictions on pile driving foundations can impact the pace of construction. Helen Bailey et al., *Assessing Underwater Noise Levels During Pile-Driving at an Offshore Windfarm and its Potential Effects on Marine Mammals*, 60 MARINE POLLUTION BULL. 888, 891 (2010).

288. Onshore wind developments have operational restrictions under the Endangered Species Act and the Bald and Golden Eagle Protection Act to protect birds and bats. 16 U.S.C. §§ 1531–44; 16 U.S.C. § 668–668d.

289. Information Memorandum at 16 (May 10, 2021). https://www.boem.gov/sites/default/files/documents/renewable-energy/state-activities/VW1-OCSLA-Compliance-Memo-ROD-Appendix-B.pdf.

resource lost when balancing all the factors required for approval of a project.[290]

*2. Building unnecessary infrastructure*

The Model Act and several state statutes include the "drilling of unnecessary wells" within their definitions of "waste" of oil and gas.[291] Similarly, some federal officials have used their discretion to designate unnecessary wells as waste even though this language is not explicitly included in the definition of waste under the federal regulations.[292]

One rationale for considering excess wells as waste is the added expense to private-party holders of correlative rights to erect offset wells when these wells do not ultimately increase the overall recovery from a reservoir. While this is a private concern, drilling only necessary wells also has several public impacts including (1) minimizing impacts on marine life; (2) reducing potential sources of pollution; and (3) preventing diversion of scarce equipment and expert manpower from more productive uses.[293]

As discussed in Section IV.B above, subsequent development of upwind farms has significantly impacted preexisting downwind farms, rendering them non-economic because the energy they had relied upon for paying back their initial costs has now been stolen.[294] The Texas study showed the downwind farm lost revenue and production tax credits of almost three- million dollars annually, and in the North Sea the efficiency of the Nysted wind project dropped twenty-one percent after installation of the Rødsand II project upwind.[295] When newer upwind developers have no liability for their impact on an existing downwind farm, they have no incentive to coordinate or compensate impacted downwind turbines.[296] The result is, at worst, closure of the preexisting downwind farm, or at least, significantly more infrastructure—in terms of turbines, connected wiring,

290. *Id.* (quoting *Fox Television Stations, Inc.*, 556 U.S. at 509).
291. *See supra* notes 140–41 and accompanying text.
292. *See supra* notes 177–81 and accompanying text.
293. *See supra* notes 194–96 and accompanying text.
294. *See supra* notes 220–24 and accompanying text.
295. K.K. DuVivier, *Can Political Headwinds against U.S. Offshore Wind Power Help Policy Change Course?*, CTR. PROGRESSIVE REFORM (Mar. 19, 2020), http://progressivereform.org/cpr-blog/can-political-headwinds-against-us-offshore-wind-power-help-policy-change-course [https://perma.cc/NQ2U-73K8]; *see also* Lundquist et al., *supra* note 206, at 26–27; Nicolai Gayle Nygaard, *Wakes in Very Large Wind Farms and the Effect of Neighbouring Wind Farms*, 524 J. PHYSICS: CONF. SERIES 1, 9 (2014).
296. *See* DuVivier & Mooney, *supra* note 207, at 21, 26, 28.

substations, etc.—to exploit the same or a roughly equivalent amount of wind energy in an area.[297]

The rationales for recognizing the building of this unnecessary infrastructure as "waste" mirror those for unnecessary oil and gas wells. On a private level, developers are investing more to develop the same amount of energy.[298] On a public level, more turbines than necessary create more opportunities to interfere with marine life and other OCS uses of the area, including fishing.[299] While more turbines may not be as great a risk of pollution as more oil and gas wells that could create spills, there still is more potential for pollution with each site.[300] Finally, and perhaps most importantly, each turbine represents costs to society for manufacturing the base, tower, blades, gears, and generators, which require the mining of source parts, including mining of rare earths, and the need for recycling or disposing of all of this equipment when they reach the end of their life cycle.[301]

Regulators could address this issue by recognizing, as some European countries have done, the value of the wind energy to the existing wind farm and requiring compensation for losses.[302] In addition, the government forces oil and gas operators to share pipelines and platforms, and regulators could mandate similar sharing for transmission lines and some other wind project infrastructure.[303]

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297. *Id.* at 12, 13, 16–20.

298. David E. Pierce, *Minimizing the Environmental Impact of Oil and Gas Development by Maximizing Production Conservation*, 85 N.D.L. REV. 759, 760–61, 769–70 (2009).

299. *See supra* notes 281–85 and accompanying text.

300. OFFICE OF ENERGY EFFICIENCY AND RENEWABLE ENERGY, ENVIRONMENTAL IMPACTS AND SITING OF WIND PROJECTS, https://www.energy.gov/eere/wind/environmental-impacts-and-siting-wind-projects [https://perma.cc/G7ZY-C39D].

301. *See* U.S. Energy Information Administration, *Average U.S. Construction Costs for Solar and Wind Generation Continue to Fall* (Sept. 16, 2020), https://www.eia.gov/todayinenergy/detail.php?id=45136 [https://perma.cc/2WED-HPTU].

302. *See* DuVivier & Mooney *supra* note 297, at 30–32 (describing the Danish and British governments' differing approaches to compensating existing wind farm owners for losses as a result of newer developments).

303. Texas Rice Land Partners, Ltd. v. Denbury Green Pipeline-Tex., LLC, 363 S.W.3d 192, 200, 202 (Tex. 2012) (holding that the eminent domain clause of the Texas Constitution only allows a taking for pipeline construction if the pipeline is for public use and there is a "reasonable probability" that the pipeline will be used to carry oil or gas for another party other than the one constructing the pipeline).

## CONCLUSION

The United States has vast offshore wind resources—nearly double the total electricity consumption of the country—located near some of the largest population centers, and therefore, electricity load, centers.[304] This abundance has remained untapped for over a decade, putting the United States behind its peers worldwide. Yet, a more urgent focus on climate change and President Biden's executive order promise to bring on an unprecedented rush of offshore wind development in U.S. waters.

While the United States is a world leader in onshore wind energy, that development has come at the price of heavy waste of the resource. Under a common law rule of capture like the one applied in the early days of oil and gas development, individual wind developers have an incentive to maximize energy recovery within their own wind farms, but they have no incentive to maximize recovery of the entire resource.

Uniformity of ownership by the federal government should facilitate consistent, cooperative wind development that is not possible on land because of the competing priorities of different owners. Lessons learned from common law waste and state oil and gas waste statutes, as well as federal regulations on the topic, can inform the promulgation of regulations that will best facilitate the development of offshore wind. Specifically, two criteria should guide offshore wind development—maximizing the quantity of resource recoverable and avoiding the construction of unnecessary infrastructure to harvest it.

There is even more reason in this context than in the oil and gas context to maximize recovery of the entire U.S. offshore wind resource. While maximizing an oil and gas field simply contributes more greenhouse-gas-producing product, maximizing carbon-free energy production benefits the U.S. public, as well as the world, by helping mitigate climate change. Furthermore, offshore wind on federal lands is an asset collectively owned by all U.S. citizens, and maximizing production can generate maximum payments to the public.[305]

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304. Liz Hartman, *Computing America's Offshore Wind Energy Potential*, OFFICE OF ENERGY EFFICIENCY AND RENEWABLE ENERGY (Sept. 9, 2016), https://www.energy.gov/eere/articles/computing-america-s-offshore-wind-energy-potential [https://perma.cc/9B9P-KRMS].

305. In the oil and gas setting, these payments might be royalties, but with wind energy, the public receives lease auction payments, rents, and operating fees.

As with oil and gas development, regulation of wind is required to prevent waste and to force consideration of the correlative rights of other developers in a common pool. Recognizing the value of wind energy losses by construction of upwind farms or in the context of spacing compromises, and ultimately, utilizing cooperative development in the form of resource-wide development plans, spacing rules, and providing shared returns for turbines along lease boundaries may be some of the best solutions for preventing wind waste.