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Property Rights and Modern Energy

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PROPERTY RIGHTS AND MODERN ENERGY

*Troy A. Rule**

INTRODUCTION

Throughout its existence, property law has evolved and adapted in response to social and technological change. Some of the most influential property scholarship of the past half century has centered on this evolutionary process, identifying factors that tend to spark the initial formation of property rights in an asset, influence the optimal structuring of new property-rights regimes, and warrant adjustments to such regimes over time.¹

History has shown that making calculated changes to existing property arrangements is sometimes necessary to ensure that property law facilitates rather than hinders energy innovation in this ever-changing world. For instance, the importance of energy from simple watermills in the eighteenth century prompted some state legislatures to allow mill owners to flood neighbors' land, provided the neighbors received compensation.² And in the twentieth century, concerns about wasteful oil extraction practices under a strict common law "rule of capture" led many states to ultimately develop compulsory unitization laws.³

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¹ Countless articles are worthy of reference here, so the following string of citations is by no means meant to be exhaustive. *See, e.g.*, Harold Demsetz, *Toward a Theory of Property Rights*, 57 AM. ECON. REV. 347 (1967) (using examples such as the relationship between commercial fur trading and private-property rights in land to describe conditions and factors that tend to lead to the emergence of property rights); Robert C. Ellickson, *Property in Land*, 102 YALE L.J. 1315 (1993) (describing factors affecting the efficiency of various forms of property interests in land); Carol M. Rose, *Crystals and Mud in Property Law*, 40 STAN. L. REV. 577 (1988) (discussing why the rules governing some types of property rights become more or less clear over time).

² *See* Morton J. Horwitz, *The Transformation of American Law, 1780-1860*, in ENERGY, ECONOMICS AND THE ENVIRONMENT 120, 120-21 (3d ed. 2010). A 1795 Massachusetts statute, for example, required that the mill owner pay compensation for damages caused by the flooding—the equivalent of "liability-rule" protection. *See id.* at 121. For more on liability rules and their potential as a means of adjusting property rights in response to technological change, see *infra* Part V.

³ Compulsory unitization statutes provide for the combining of oil and gas field leases into larger collective operations, thereby mitigating incentives for overextraction and waste. With the exception of Texas, all major oil-producing states have adopted compulsory unitization laws. *See* Jacqueline Lang Weaver, *The Tragedy of the Commons from Spindletop to Enron*, 24 J. LAND RESOURCES & ENVTL. L. 187, 187 (2004); Gideon Wiginton, Comment, *Addressing Perceptions of Procedural Unfairness in Compulsory Unitization by Appointing Neutral Experts*, 55 AM. U. L. REV. 1801, 1811-12 (2006). Texas law allows for voluntary unitization, TEX. NAT. RES. CODE ANN. §§ 101.001-.052 (West 2011), and empowers the state Railroad Commission to compel the pooling of oil and gas interests in a common

Today, new property-rights issues arising from innovations in energy development are once again stretching the bounds of property law. A burgeoning worldwide energy demand⁴ and persistent concerns about the environmental impacts of coal and oil emissions⁵ are driving unprecedented levels of interest in a younger generation of energy technologies. Although coal and conventionally extracted oil and gas continue to account for most of the United States' domestic energy production,⁶ the nation is increasingly turning to renewable energy sources and hydraulic fracturing techniques to meet its energy needs.⁷ At the same time, there is also growing interest in storing carbon dioxide gas underground as one way of potentially slowing the pace of global climate change.⁸ As these novel forms of energy and climate-related development spread across the country, they are raising complicated property-rights questions involving wind currents, sunlight, deep underground mineral deposits, subsurface pore space, and other resources. Because laws to govern these complex questions are underdeveloped in many jurisdictions, legal scholars and policymakers have a relatively clean slate to work from in addressing them.

Fair, efficient property laws that are tailored to the unique characteristics of today's emerging energy technologies have an important role to play in helping the United States to achieve energy sustainability. Legal rules that appropriately balance competing property interests and avoid conflicts

reservoir, Mineral Interest Pooling Act, *id.* §§ 102.001-.112. See Paula C. Murray & Frank B. Cross, *The Case for a Texas Compulsory Unitization Statute*, 23 ST. MARY'S L.J. 1099, 1122-27 (1992).

⁴ See U.S. ENERGY INFO. ADMIN., INTERNATIONAL ENERGY OUTLOOK 2011, at 1 (2011), available at [http://www.eia.gov/forecasts/ieo/pdf/0484\(2011\).pdf](http://www.eia.gov/forecasts/ieo/pdf/0484(2011).pdf) (reporting that total global energy consumption grew from 354 quadrillion Btu in 1990 to 505 quadrillion Btu in 2008 and is projected to reach 770 quadrillion Btu by 2035).

⁵ For example, the potential climate impacts of fossil-fuel emissions continue to raise policy concerns. The U.S. Environmental Protection Agency has concluded that at least six greenhouse gases heavily emitted by coal and oil combustion, including carbon dioxide, are contributing to global climate change. See Endangerment and Cause or Contribute Finding for Greenhouse Gases Under Section 202(a) of the Clean Air Act, 74 Fed. Reg. 66,496, 66,497 (Dec. 15, 2009) (concluding that the "body of scientific evidence compellingly supports" the finding that greenhouse gases promote climate change effects that "endanger public health" and welfare).

⁶ As of 2011, fossil fuels such as coal, oil, and natural gas accounted for about 77 percent of primary energy production in the United States. See U.S. ENERGY INFO. ADMIN., ANNUAL ENERGY REVIEW 2011, at 7 (2012), available at <http://www.eia.gov/totalenergy/data/annual/archive/038411.pdf>. Presently, only a minority of the natural gas produced in the United States is obtained through hydraulic fracturing techniques. See INDEP. PETROLEUM ASS'N OF AM., HYDRAULIC FRACTURING: EFFECTS ON ENERGY SUPPLY, THE ECONOMY, AND THE ENVIRONMENT (2008), available at <http://www.energyindepth.org/PDF/Hydraulic-Fracturing-3-E's.pdf> (asserting that hydraulic fracturing accounts for about 30 percent of U.S. recoverable oil and gas reserves).

⁷ See U.S. ENERGY INFO. ADMIN., ANNUAL ENERGY REVIEW 2010, at 290 (2011), available at <http://www.eia.gov/totalenergy/data/annual/archive/038410.pdf> (showing significant increases in total U.S. renewable energy consumption from 1949 to 2010 and particularly steep growth from 2000 to 2010).

⁸ For more detailed information about this topic, see *infra* Part III.B.2.

can do much to promote modern energy strategies and tend to require far fewer tax dollars than subsidies or grant programs. Unfortunately, despite volumes of legal scholarship on the evolution and structuring of property-rights regimes, there is minimal consensus among lawmakers or within the legal academy regarding how best to adapt such regimes to modern energy innovation. As they have in the past, courts and legislatures will unquestionably need to adjust some existing property structures to accommodate and encourage new forms of energy development. But at what point does such fine-tuning go too far, altering long-established property arrangements in ways that are neither fair nor efficient?

This Article describes and analyzes several ways of adjusting property-rights regimes in response to social or technological change and offers some general guidelines for adapting property law to the energy innovations of the twenty-first century. Among other things, this Article emphasizes that the most equitable and efficient adjustments to property-rights regimes are those that *respect* rather than *disregard* property owners' existing entitlements. Part I of this Article offers a brief summary of the evolution of property rights in energy resources in the United States and describes how breakthroughs in the energy industry are once again creating pressure to modify current property arrangements. Part II argues that, when feasible, merely clarifying ambiguities in existing law can be the most fair and efficient way to respond when new technologies place pressure on existing property structures. Part III identifies and analyzes policies that respond to such pressure by effectively converting private-property rights into "commons" property or vice versa. Part IV focuses on policies that respond to this pressure by redistributing existing property rights among private citizens or to government entities to favor a particular type of resource use. Such policies have a problematic tendency to ignore citizens' long-held entitlements and prevent fair and optimal allocations of the resources involved. Part V suggests that laws that strategically protect particular property interests with "liability rules" rather than "property rules" can be a useful way to adjust property rights in energy-related resources without disregarding citizens' existing rights in those resources. Relying on recent examples from the energy sector to illustrate its concepts, this Article seeks to add to the discussion of how best to adapt property law to the energy challenges of the next half century and beyond.

I. BACKGROUND

Property law has profoundly impacted the development of the U.S. energy industry throughout its history. The United States has long relied on

coal, petroleum, and natural gas to supply most of its energy needs.⁹ Laws have gradually developed over time to allocate and govern property interests in these valuable resources, with varying degrees of success. Policymakers' past feats and failures at the intersection of energy law and property law can be instructive for policymakers as they seek to address the numerous unresolved property-rights issues arising in the energy sector today.

A. *Property Rights and Energy Resources: A Historical Perspective*

Contemporary property laws governing most subsurface energy sources are ultimately traceable to the old common law maxim, "*cujus est solum, ejus est usque ad coelum et ad inferos*,"¹⁰ meaning, "[t]o whomsoever the soil belongs, he owns also to the sky and to the depths."¹¹ Taken literally, this rule would vest landowners with title to all of the minerals and other deposits located directly below the surface of their parcels, to the center of the earth. Courts have rightly refused to literally interpret the *ad coelum* rule as dividing property rights up into outer space or down to the earth's core.¹² However, more practical applications of the rule can be appealing in their simplicity, using existing boundary lines to clearly delineate subsurface and airspace interests among landowners.¹³ The rule provides the foundational basis for common law mineral rights in the United States, allocating private ownership interests in coal and other stationary subsurface mineral deposits to the owners of surface land immediately above those resources.¹⁴ Contemporary mineral rights laws based on the *ad coelum* rule seem to do a decent job of apportioning property interests among landowners and thereby limiting neighbor disputes, facilitating efficient exchanges of mineral rights, and encouraging investment in these valuable assets.

Although laws generally applying the *ad coelum* rule have been relatively effective at allotting interests in coal and other immobile subsurface minerals, they have proven far less suitable in the context of oil and gas. Unlike coal, oil and gas are fugitive energy resources that can migrate across subsurface property boundaries during extraction activities. Particu-

⁹ See ANNUAL ENERGY REVIEW 2010, *supra* note 7, at 8-9 (showing that petroleum, coal, and natural gas have accounted for the bulk of U.S. primary energy consumption since 1949).

¹⁰ John G. Sprankling, *Owning the Center of the Earth*, 55 UCLA L. REV. 979, 980-92 (2008).

¹¹ BLACK'S LAW DICTIONARY 453 (rev. 4th ed. 1968).

¹² See, e.g., *United States v. Causby*, 328 U.S. 256, 260-61 (1946) (declaring that the *ad coelum* "doctrine has no place in the modern world" in which airplanes traverse the skies).

¹³ For more detailed information regarding both the benefits and costs of "exclusion" property regimes like the *ad coelum* rule, see generally Henry E. Smith, *Exclusion Versus Governance: Two Strategies for Delineating Property Rights*, 31 J. LEGAL STUD. S453 (2002).

¹⁴ See Eric R. Claeys, *Exclusion and Exclusivity in Gridlock*, 53 ARIZ. L. REV. 9, 33 (2011) ("[P]roperty law applies the *ad coelum* principle to assign ownership over mineral rights to the owner of the overlying ground.").

larly in the early days of oil exploration, difficulties in measuring how much oil or gas resided in any given field and in determining the precise dimensions of oil fields made divvying up oil and gas interests based on surface ownership practically impossible.¹⁵

Many U.S. courts thus initially opted for an altogether different allocation rule for oil and gas—the common law “rule of capture.”¹⁶ This basic approach, which courts had long used to govern property interests in wild animals, allowed landowners to claim title to any oil and gas that they were able to “capture” via vertical wells on their land.¹⁷ To analogize between oil and gas and wild animals and apply similar policies to allocate interests in both categories of resources must have been an enticing solution at the time. Oil, gas, and wild animals are all capable of wandering across parcel boundaries until someone seizes them, so a single rule that rewards capturers could understandably have seemed workable for all of these resources as well.

Unfortunately, applying a strict rule of capture to oil and gas was not as effective as policymakers surely hoped it would be. The rule produced widespread inefficiency in the oil and gas industry, incentivizing parties to extract oil as quickly as possible to prevent neighbors from claiming it. This race for oil rapidly depleted the pressure in many oil fields, dramatically reducing the amount of oil produced.¹⁸ Over the years, laws applying an unmitigated rule of capture have thus been sharply criticized for causing extensive overextraction and waste.¹⁹

Policymakers eventually established greater order and efficiency in the oil and gas industry by developing new legal rules to supplement the basic rule of capture. Among these improved laws were rules that facilitated unit-

¹⁵ See Henry E. Smith, *Exclusion and Property Rules in the Law of Nuisance*, 90 VA. L. REV. 965, 1027-28 (2004) (noting the difficulty of extending the *ad coelum* doctrine to oil and gas rights because “oil was out of sight and moved around in response to drilling activities” and it was “difficult to know how much oil . . . existed under a given parcel”).

¹⁶ *Id.*

¹⁷ See *id.* at 1028 (explaining that under the rule of capture, landowners could claim title to “any oil they reduce[d] to possession at the surface”).

¹⁸ See, e.g., FRED BOSSELMAN ET AL., *ENERGY, ECONOMICS AND THE ENVIRONMENT* 254 (3d ed. 2010) (noting that overextraction of a major oil field in Spindletop, Texas, “depleted the field’s pressure so quickly that . . . [l]ess than five percent of the field’s oil was produced”).

¹⁹ See Gary D. Libecap & James L. Smith, *The Economic Evolution of Petroleum Property Rights in the United States*, 31 J. LEGAL STUD. S589, S592 (2002) (“In 1914, the director of the Bureau of Mines estimated that the costs of excessive wells equaled about a quarter of the value of total annual U.S. oil production.”); see also Smith, *supra* note 15, at 1028 (stating that use of the rule of capture for oil and gas is “one of the most criticized examples of ‘formalistic’ reasoning”). Judge Richard Posner has also cited use of the rule of capture for oil and gas as an example of the dangers of formalism. He argues that while such an approach may spare policymakers from “having to delve into the economics of developing” a newly valuable resource, “the risk that the resulting regime . . . will be inefficient” in such situations “is very great.” RICHARD A. POSNER, *OVERCOMING LAW* 399 (1995), cited in Smith, *supra* note 15, at 1029.

ization—the merging of multiple landowners’ oil and gas interests into a single unit and appointing of a single manager to oversee extraction activities and fairly allocate among the owners the revenues generated from extraction.²⁰ Although they took several decades to develop, contemporary unitization laws now enacted in many states do a decent job of governing oil and gas interests.²¹ These laws are more carefully tailored to strike an acceptable balance between honoring landowners’ existing interests in subsurface resources and promoting economically efficient extraction practices.

B. *Energy Innovation’s Increasing Pressure on Property Arrangements*

Because of the United States’ relative abundance of energy resources, the U.S. energy industry has managed to flourish over the past 150 years in spite of the sometimes slow and bumpy evolution of oil and gas law.²² Unfortunately, the energy policy challenges facing the nation today are far more daunting than those of a century ago and leave less room for error and delay in crafting appropriate solutions.

The growing scarcity of fossil-fuel resources and mounting evidence of their potential climate-change impacts²³ raise significant doubts about the long-term sustainability of the nation’s current energy habits. Over the past decade, policymakers in the United States have thus increasingly sought to

²⁰ See Jacqueline Lang Weaver & David F. Asmus, *Unitizing Oil and Gas Fields Around the World: A Comparative Analysis of National Laws and Private Contracts*, 28 HOUS. J. INT’L L. 3, 7, 16-18 (2006).

²¹ See David W. Eckman, *Statutory Fieldwide Oil and Gas Units: A Review for Future Agreements*, 6 NAT. RESOURCES LAW. 339, 346-48, 381 (1973) (describing statutory unitization as “the best[] of many conservation measures initiated to prevent waste and protect the correlative rights of owners entitled to enter and exhaust the common reservoir”); Lang Weaver & Asmus, *supra* note 20, at 11-12 (delineating several reasons why “[u]nitization is generally acknowledged as the best method of producing oil and gas efficiently and fairly”).

²² Commercial oil extraction had been occurring in the United States for nearly a century before policymakers finally enacted contemporary unitization-assistance laws. See Libecap & Smith, *supra* note 19, at S591-95 (reporting that producers were extracting oil in the mid-nineteenth century but that unitization did not become popular until the late 1940s and early 1950s). Some of this lag between the commencement of oil drilling and the enactment of legal rules to appropriately govern oil and gas interests was probably attributable to the fact that oil and gas were less scarce and valuable in the early years of extraction.

²³ See Endangerment and Cause or Contribute Findings for Greenhouse Gases under Section 202(a) of the Clean Air Act, 74 Fed. Reg. 66,496, 66,497-99 (Dec. 15, 2009) (concluding that there is “compelling support for finding that greenhouse gas air pollution,” attributable in part to transportation emissions, “endangers the public welfare of both current and future generations”).

address these issues by promoting greater energy conservation and by encouraging reliance on a broader diversity of energy resources.²⁴

A U.S. energy portfolio that has long been dominated by coal and conventionally extracted petroleum is gradually transitioning toward shale gas and more environmentally friendly sources such as wind energy, solar energy, and biofuels.²⁵ Governments are also beginning to explore the possibility of using underground spaces to store carbon dioxide as a means of combatting climate change.²⁶ These next-generation energy strategies are giving rise to a wide array of thorny property law questions that will need to be addressed in the coming years. What principles should guide policymakers in their effort to adjust property law to the energy challenges of the twenty-first century?

II. POLICIES THAT CLARIFY EXISTING PROPERTY-RIGHTS REGIMES

Often, the least disruptive way for courts and legislatures to adapt property law over time is simply to resolve legal ambiguities regarding the scope and character of property rights as such ambiguities arise. As technological advancements or other factors cause particular types of scarce assets to serve novel uses and increase in value, new property conflicts can emerge.²⁷ Legal uncertainty associated with these conflicts can impose social costs by discouraging investment in valuable new property uses and slowing their rate of adoption. When available, legal rules that eliminate gray areas in existing property law that come to light through new technologies are often the lowest-cost way of adapting property law to changing times. As shown by the following two examples involving subsurface pore

²⁴ For a useful account of various proposed policies for promoting energy conservation and reducing energy demand, see generally Noah M. Sachs, *Greening Demand: Energy Consumption and U.S. Climate Policy*, 19 DUKE ENVTL. L. & POL'Y F. 295 (2009).

²⁵ See U.S. ENERGY INFO. ADMIN., MONTHLY ENERGY REVIEW: JUNE 2012, at 4-5 (2012), available at <http://www.eia.gov/totalenergy/data/monthly/archive/00351206.pdf> (showing decreases in aggregate domestic production of coal and oil from 2001 to 2012 and increases in aggregate production of renewable energy and natural gas over the same period). Although biofuels are an important and growing part of the U.S. energy portfolio and policies relating to them can raise fascinating land use issues, discussions of these issues are beyond the narrow scope of this Article. For readers interested in exploring the interrelation between biofuels and land use allocations, see generally Daniel A. Farber, *Indirect Land Use Change, Uncertainty, and Biofuels Policy*, 2011 U. ILL. L. REV. 381 (2011).

²⁶ More specific information on the topic of carbon capture and storage follows later in this Article. See *infra* Part III.B.2.

²⁷ Professor Harold Demsetz observed this relationship between the value of an asset and its tendency to spur disputes in his famous article, *Toward a Theory of Property Rights*. Demsetz, *supra* note 1, at 350; see also *infra* notes 55-57 and accompanying text.

space and wind rights, such clarifications can be instrumental in promoting more optimal use of the scarce resources at issue.²⁸

A. *Laws that Clarify Property Interests in Subsurface Pore Space*

One recent example of an effort to clarify property rights in the energy context is the growing number of state statutes providing that surface owners hold title to the “pore space” below their land.²⁹ Subsurface pore space can be highly valuable as a place to store carbon dioxide gases emitted from fossil-fuel combustion.³⁰ Such space is also sometimes used for storing previously extracted natural gas.³¹ Disputes over the ownership and use of subsurface pore space can arise whenever a holder of a severed mineral estate engages in extraction or mining activities that create a large volume of this space under the ground.³² In such instances, there can be uncertainty regarding whether this pore space belongs to the surface owner or to the mineral rights holder. Surface owners may argue that the space is not “minerals” and hence belongs to them under the *ad coelum* doctrine described above.³³ Holders of severed mineral rights might counter that such subsurface space is a part of the minerals estate and thus rightly belongs to them.³⁴

To reduce legal uncertainty regarding the ownership of subsurface pore space, legislatures in at least three states have now enacted laws ex-

²⁸ One other example of an effort to clarify property rights in response to a new conflict arising from energy innovation can be found in a relatively recent case involving mineral rights holders’ interests in geothermal steam, which can be used to generate electric power. *See Rosette, Inc. v. United States*, 64 F. Supp.2d 1116, 1119-21, 1123 (D.N.M. 1999) (holding that the federal government’s reservations of “other minerals” in certain land patents included interests in geothermal resources and that water rights under such patents did not include rights in geothermal steam), *aff’d*, 277 F.3d 1222 (10th Cir. 2002).

²⁹ *See, e.g.*, N.D. CENT. CODE § 47-31-03 (Supp. 2011); WYO. STAT. ANN. § 34-1-152 (2009); *see also* James Robert Zadick, *The Public Pore Space: Enabling Carbon Capture and Sequestration by Reconceptualizing Subsurface Property Rights*, 36 WM. & MARY ENVTL. L. & POL’Y REV. 257, 259 (2011).

³⁰ More detailed descriptions of carbon dioxide sequestration and storage are available. *See* Alexandra B. Klass & Elizabeth J. Wilson, *Climate Change, Carbon Sequestration, and Property Rights*, 2010 U. ILL. L. REV. 363, 364 (2010); *see also infra* notes 81-83 and accompanying text.

³¹ For an introductory discussion of this use of subsurface pore space and some legal issues it presents, *see generally* THOMAS W. MERRILL & HENRY E. SMITH, *PROPERTY: PRINCIPLES AND POLICIES* 112-13 (2d ed. 2012).

³² *See* R. Lee Gresham & Owen L. Anderson, *Legal and Commercial Models for Pore-Space Access and Use for Geological CO₂ Sequestration*, 72 U. PITT. L. REV. 701, 709 (2011) (noting that “[t]he question of pore-space ownership most commonly arises when the fee-simple interest is severed into a surface estate and one or more separate mineral interests,” that “few states have statutorily or judicially determined who owns the pore space,” and that “[i]n many states, the questions of pore-space ownership and use rights would be ones of first impression”).

³³ *See supra* notes 11-14 and accompanying text.

³⁴ *See* Gresham & Anderson, *supra* note 32, at 709-10.

pressly providing that title to such space belongs to surface owners.³⁵ Such laws clear up a previously unresolved question of property law raised to new importance by the advent of new energy-related technologies, enabling parties to more confidently transact and make investments in this valuable space.³⁶

B. *Laws that Clarify the Nonseverability of Wind Estates*

State legislatures have also made efforts in recent years to clarify whether wind-energy development rights are severable from surface rights in land. Statutes recently enacted in a growing number of states make clear, among other things, that such “wind rights” cannot be severed from the surface estate and separately conveyed to third parties.³⁷

Wind-energy development has expanded at an astounding pace in the United States over the past decade. Although wind-energy resources currently supply only about 3 percent of the nation’s energy needs, that percentage is rapidly growing.³⁸ In the ten-year period from 2001 to 2011, the country’s aggregate installed wind-energy capacity increased by more than tenfold.³⁹ Although the possible expiration of federal production tax credits for commercial wind-energy development could slow U.S. wind-energy development after 2013,⁴⁰ the nation’s total wind-energy-generating capacity will likely continue to grow for many years to come. Wind energy is highly desirable from an environmental standpoint because wind turbines

³⁵ See MONT. CODE ANN. § 82-11-180 (2009); N.D. CENT. CODE §§ 47-31-01 to -08 (Supp. 2011); WYO. STAT. ANN. § 34-1-152 (2010); see also Klass & Wilson, *supra* note 30, at 382 & n.131.

³⁶ An example of this sort of clarification by a court in response to advancements in energy technology is found in *Amoco Production Co. v. Southern Ute Indian Tribe*, which held that reservations of “coal” rights in land patent grants under the 1909 and 1910 Coal Lands Acts did not include reservations of coalbed methane—a subsurface gas resource that had little commercial value when the Coal Lands Act was enacted but that can be highly valuable today. 526 U.S. 865, 867-68, 880 (1999).

³⁷ See, e.g., MONT. CODE ANN. § 70-17-404 (2011); NEB. REV. STAT. § 76-3004 (2009); N.D. CENT. CODE § 17-04-04 (2012); S.D. CODIFIED LAWS § 43-13-19 (2004); WYO. STAT. ANN. § 34-27-103 (2011).

³⁸ See Ehren Goossens & Justin Doom, *U.S. Wind Energy Capacity up 31 Percent in 2011*, BLOOMBERG (Apr. 12, 2012), <http://www.bloomberg.com/news/2012-04-12/kansas-texas-led-31-gain-in-u-s-wind-energy-capacity-in-2011.html> (noting that about 3 percent of all energy supplied in the United States in 2011 came from wind and that total wind-energy-generating capacity had increased by 31 percent in 2011).

³⁹ See AM. WIND ENERGY ASS’N, AWEA U.S. WIND INDUSTRY: FIRST QUARTER 2012 MARKET REPORT 4 (2012), available at http://www.awea.org/learnabout/publications/reports/upload/AWEA_First_Quarter_2012_Market_Report_Public.pdf (reporting an increase from just 4,144 megawatts of installed capacity in 2001 to 46,916 megawatts in 2011).

⁴⁰ A bill passed in January of 2013 essentially extended these credits for one year, such that they are presently slated to expire for wind-energy projects not commenced by the end of 2013. K. Kaufmann, *Wind Energy Tax-Credit Extension Part of ‘Cliff’ Deal*, USA TODAY (Jan. 2, 2013), <http://www.usatoday.com/story/news/nation/2013/01/02/fiscal-cliff-wind-energy-extension/1804447>.

can generate significant quantities of renewable power for decades without emitting carbon dioxide gases into the atmosphere that could contribute to global warming.

In recent years, some landowners have begun executing documents purporting to sever wind rights from the fee estate.⁴¹ Such severance, which has long been a legally recognized practice for mineral rights in most jurisdictions,⁴² can arguably give landowners additional flexibility in the context of estate planning. For example, if permitted under applicable law, wind-rights severance would enable a parent to devise wind rights to a particular son or daughter who lives offsite and to separately devise the surface rights to a different child who intends to take over operations at the family's ranch or farm. However, as at least one commentator has recently noted, current legal uncertainty regarding wind estate severance could deter investment in wind energy if courts or legislatures in other states continue to neglect it.⁴³

Although the permissibility of wind-rights severance remains an unresolved issue in many states, a growing number of state legislatures are enacting laws that prohibit the practice.⁴⁴ Based on this trend, there appears to be a growing consensus that laws allowing severance of wind rights based upon analogies to mineral rights would not be in the best interest of the wind-energy industry. By clearly disallowing such severances by statute,⁴⁵ legislatures in many states are helping to reduce legal controversy and confusion that could otherwise impede the growth of wind energy within their jurisdictions.

C. *What About when Merely Clarifying Existing Property Arrangements Is Not Enough?*

Unfortunately, property law cannot always adequately adapt to technological or societal progress through mere clarifications of existing property

⁴¹ For a more detailed description of wind rights severance and footnoted citations to numerous articles discussing and analyzing this practice, see generally K.K. DuVivier, *Animal, Vegetable, Mineral—Wind? The Severed Wind Power Rights Conundrum*, 49 WASHBURN L.J. 69 (2009).

⁴² *Id.* at 77-84 (describing at great length the evolution of laws governing mineral severance).

⁴³ *See id.* at 86 (noting “that many commercial-scale wind investors are hesitant to work with landowners who have severed their wind rights” because of the legal uncertainty associated with the practice and concluding that “the traditional rationales for mineral severance do not support severance as the most effective method for encouraging the development of wind power”).

⁴⁴ *See supra* note 37 and accompanying text.

⁴⁵ It should be noted that wind rights severances that occurred prior to the enactment of such laws may be “grandfathered” in and still be enforceable. *See, e.g.*, WYO. STAT. ANN. § 34-27-103(f) (2011) (providing that nothing in Wyoming’s legislation disallowing wind-rights severance “shall alter, amend, diminish, or invalidate wind energy agreements or conveyances made or entered into prior to April 1, 2011”).

regimes.⁴⁶ New innovation can sometimes introduce valuable new resource uses that policymakers who initially structured property rights in the resource did not contemplate. And sometimes merely clarifying existing property arrangements is not enough to prevent these new uses from being underutilized. How and to what extent should property rights be adjusted in these situations?

Updating property laws in these contexts requires the careful balancing of two competing goals. On the one hand, there are often compelling reasons to safeguard the stability of existing property-rights regimes. Preserving such stability has long been among property law's most fundamental and important functions.⁴⁷ Predictable, enforceable laws that clearly assign and protect valuable entitlements in scarce resources lessen transaction costs that might otherwise impede efficient private bargaining and prevent resources from flowing to their highest-valued uses.⁴⁸ Well-defined and stable property-rights regimes also reduce legal uncertainty, encouraging more optimal levels of investment in and development of scarce resources.⁴⁹ Given the efficiency and fairness benefits of consistent property arrangements, it is hardly surprising that clarity and stability have long been key aims of property law.⁵⁰

On the other hand, allowing property-rights regimes to adjust over time is sometimes requisite to promoting allocative efficiency and social

⁴⁶ Concededly, it is not always apparent whether a court or legislature's new legal rules affecting property arrangements in the face of new technology are *clarifying* existing laws or *altering* them. See, e.g., BOSSelman ET AL., *supra* note 18, at 201 (describing the Kentucky Supreme Court's upholding of an amendment to the Kentucky state constitution that reversed decades-old case law and arguably re-assigned mineral rights holders' valuable surface rights to surface owners upon the rise of surface mining practices on the ground that the amendment merely "clarified" rather than changed).

⁴⁷ See Abraham Bell & Gideon Parchomovsky, *A Theory of Property*, 90 CORNELL L. REV. 531, 538, 552 (2005) (asserting that property law itself "is organized around creating and defending the value inherent in stable ownership" and that "the benefits provided by property systems increase with the stability of the property rights they create").

⁴⁸ The concept that laws clearly assigning entitlements are essential for Coasean bargaining and allocative efficiency is ubiquitous in law and economics scholarship and was famously highlighted by Professor Ronald Coase in 1960. See generally R. H. Coase, *The Problem of Social Cost*, 3 J.L. & ECON. 1 (1960).

⁴⁹ Professor Carol Rose has emphasized this point, noting that "[h]ard-edged rules define assets and their ownership in such a way that what is bought stays bought and can be safely traded to others, instead of repeatedly being put up for grabs." Rose, *supra* note 1, at 591. According to Professor Rose, replacing hard-edged rules with more nuanced ones can "make entitlements uncertain and thus increase the costs of trading and of resolving disputes at the same time that they discourage careful planning." *Id.* at 609.

⁵⁰ The benefits of stable property rights are often emphasized in property law scholarship. See, e.g., Bell & Parchomovsky, *supra* note 47, at 531 (noting that "property law recognizes and helps create stable relationships between persons and assets, thereby allowing owners to extract utility otherwise unavailable"). Professors Abraham Bell and Gideon Parchomovsky have engaged in much more thorough analysis of the benefits of stable property systems than is possible in this Article and could be a good starting point for readers interested in this topic. See *id.* at 552-63.

progress. As important as stable property rights may be, property laws must be at least somewhat capable of adapting to social and technological change. There are countless examples of how property law has benefited society by keeping up with the times. For instance, absent such adaptability in property law, despicable nineteenth-century racially discriminatory covenants would still be enforceable⁵¹ and condominium laws never could have developed to facilitate valuable urban growth.⁵² Property law must have some capacity to evolve and adapt so as to optimally benefit society. The difficulty in modern property-law policymaking often lies in finding the right balance between the countervailing goals of stability and adaptability.

Parts III and IV below identify and analyze several categories of ways of adjusting existing property-rights arrangements in response to technological changes affecting the energy sector. Part III focuses on policies that convert “commons” property into private property and vice versa. Part IV describes laws that effectively reshuffle existing property interests among private parties or redistribute such interests to government entities without compensating those who are adversely affected. Examples from modern energy law help to illustrate each of these policy approaches.

III. TRANSFERRING PRIVATE-PROPERTY RIGHTS INTO OR OUT OF PUBLICLY SHARED COMMONS

Social or technological changes can sometimes lead to policies that create new private-property interests out of a publicly shared commons or that convert privately owned property into commons property. In its broadest and most familiar sense, “commons” resources are resources in which no one holds exclusionary rights, such that they are freely accessible by all.⁵³ When are property-right adjustments that place resources into or out of commons ownership warranted, and how can such adjustments be implemented without undermining efficiency or fairness?

⁵¹ For a useful introduction to issues surrounding racially discriminatory covenants and the U.S. Supreme Court’s invalidation of such covenants under the Equal Protection Clause in *Shelley v. Kraemer*, 334 U.S. 1 (1948), see generally Shelley Ross Saxer, *Shelley v. Kraemer’s Fiftieth Anniversary: “A Time for Keeping; A Time for Throwing Away”?*, 47 U. KAN. L. REV. 61 (1998).

⁵² Professor Donna Bennett recently published a well-supported summary of the development of condominium law in the United States. Donna S. Bennett, *Condominium Homeownership in the United States: A Selected Annotated Bibliography of Legal Sources*, 103 L. LIBR. J. 249 (2011).

⁵³ See Frank I. Michelman, *Ethics, Economics, and the Law of Property*, in *ETHICS, ECONOMICS, AND THE LAW: NOMOS XXIV 5* (J. Roland Pennock & John W. Chapman eds., 1982) (describing commons property as property in which “there are never any exclusionary rights. All is privilege. People are legally free to do as they wish, and are able to do, with whatever objects (conceivably including persons) are in the [commons].”) (quoted in Abraham Bell & Gideon Parchomovsky, *Of Property and Antiproperty*, 102 MICH. L. REV. 1, 8 n.31 (2003)).

A. *Laws Creating Private-Property Rights in Commons Resources*

Most private-property interests began as commons property but were taken out of common ownership at some point through legal rules that created exclusion rights in those interests in favor of one or more discrete parties. Professor Harold Demsetz is well known for his observations about how and when private-property rights tend to arise in assets that were historically communally shared.⁵⁴ According to Demsetz, private-property rights tend to “develop to internalize externalities when the gains of internalization become larger than the cost of internalization.”⁵⁵ The probability of reaching this tipping point grows as the rising value of a resource increases the risk that the resource will be overexploited unless someone holds exclusionary rights in it.⁵⁶ An asset can also approach this tipping point when innovations cause the costs of protecting property rights in it to decrease, as barbed wire did for rangeland in the American West.⁵⁷ By altering the balance of costs and benefits associated with commons ownership, either of these two types of changes can potentially make it worthwhile to create private-property rights in an asset that had historically been communally shared.

1. Parcelization of the Electromagnetic Spectrum

The parcelization and auctioning of interests in bands of the electromagnetic frequency spectrum is one example of the emergence of a new property-rights regime out of the commons in response to new technology. Within a short time after scientific advancements made it possible to communicate across long distances via radio signals, exclusive rights to transmit those signals at specific frequencies came to hold significant value.⁵⁸

⁵⁴ See generally Demsetz, *supra* note 1.

⁵⁵ *Id.* at 350.

⁵⁶ *Id.* at 351-53 (describing how Native Americans’ demarcation of hunting territories after the fur trade greatly increased hunting and the value of furs in colonial North America).

⁵⁷ Professor Robert Ellickson used the example of barbed wire to illustrate this principle in one of his most influential articles on property rights. Ellickson, *supra* note 1, at 1330 (noting “that innovations in technologies for marking, defending, and proving boundaries lead to more parcelization because they reduce the transaction costs of private property regimes” and citing the increased “subdivision of rangeland in the American West” after “Glidden’s invention of barbed wire in 1874” as an example of this effect).

⁵⁸ General information about radio spectrum allocations within the United States is available at the Federal Communication Commission’s website. *FCC Encyclopedia: Radio Spectrum Allocation*, FED. COMM’NS COMM’N, <http://www.fcc.gov/encyclopedia/radio-spectrum-allocation> (last visited Mar. 14, 2013). For additional information on the frequency spectrum, see Captain Roscoe M. Moore, III, *Business-Driven Negotiations for Satellite System Coordination: Reforming the International Telecommuni-*

When interference conflicts among competing transmitters began to hinder the nation's progress in radio telecommunications, Congress responded by enacting the Radio Act of 1927⁵⁹ and the Communications Act of 1934.⁶⁰

Although these federal statutes established a licensing system for radio frequencies that was a significant step toward a property-rights system, the statutes arguably fell short because they required that the Federal Communications Commission ("FCC") approve all sales of existing frequency licenses.⁶¹ For decades, Professor Ronald Coase and other legal scholars advocated more reliance on private-property arrangements to allocate spectrum rights.⁶² The FCC eventually followed their advice and auctioned off several frequency rights to private parties in the mid-1990s, and since then, private allocation approaches for such rights have generally grown more property based over time.⁶³ Because of these policy developments, a robust and well-recognized private-property-rights regime now governs a frequency spectrum that was once an ordinary commons.

Obviously, a careful weighing of social costs and benefits is critical when considering whether to convert commons property into private property. Policymakers often have the arduous task of estimating a project's true social costs and benefits and deciding whether to allow it to go forward. As the following example shows, innovative strategies within the energy industry are increasing the value of certain types of commons resources. As the economic significance of these resources continues to grow in the coming years, pressure to create private-property interests in them will likely increase as well.

cation Union to Increase Commercially Oriented Negotiations Over Scarce Frequency Spectrum, 65 J. AIR L. & COM. 51, 55-56 (1999).

⁵⁹ Radio Act of 1927, Pub. L. No. 69-632, 44 Stat. 1162 (repealed 1934), cited in Dale B. Thompson, *Of Rainbows and Rivers: Lessons for Telecommunications Spectrum Policy from Transitions in Property Rights and Commons in Water Law*, 54 BUFF. L. REV. 157, 169 & n.39 (2006).

⁶⁰ Communications Act of 1934, 47 U.S.C. § 303(c) (2006), cited in Thompson, *supra* note 59, at 169 & n.41.

⁶¹ Thompson, *supra* note 59, at 169.

⁶² See generally R. H. Coase, *The Federal Communications Commission*, 2 J.L. & ECON. 1, 16 (1959). For a concise summary of the debate over whether to manage the telecommunications spectrum through a commons or a property-rights regime, see generally Thompson, *supra* note 59, at 169-75.

⁶³ See Thompson, *supra* note 59, at 170 (noting that, after decades of government licensing and control of the radio spectrum, "the FCC finally began to follow" recommendations from Professor Ronald Coase and other scholars to use a property-rights regime to allocate radio frequency rights and "auctioned a number of frequencies off from 1994 to 1996"). It should be noted that there have been renewed calls in recent years to use something more akin to a commons system to allocate frequency rights. See *id.* at 170-72 (describing arguments by Eli Noam, Yochai Benkler, Lawrence Lessig, and others in the late 1990s and early 2000s that a commons mechanism was better suited for managing the telecommunications spectrum).

2. Privatizing Additional Airspace to Accommodate Airborne and Large-Scale Wind Turbines?

In the coming decades, airborne wind-energy technologies could generate demand for partial privatization of the high-altitude airspace known as “navigable airspace” that has long been an open-access commons reserved for air travel.⁶⁴ Airborne wind turbines, which are still in relatively early stages of development, float thousands of feet above the earth’s surface to take advantage of wind conditions that are extremely favorable for wind-energy generation.⁶⁵ Tethered to the ground by wires that also would transmit generated electricity for use below, these turbines would necessarily occupy navigable airspace.⁶⁶

If airborne wind turbines become economically viable, those wishing to install them would obviously need to acquire exclusive rights to place them into high-altitude airspace and to exclude air traffic from those areas. Turbulent wakes behind such turbines could also pose risks to air travelers in their vicinity.⁶⁷ If the government granted permits to private citizens for the placement of airborne turbines in navigable airspace and did not charge rent for the occupation of that space, such actions could be characterized as a conversion of commons property into private property.

Not unlike laws privatizing grazing lands in the nineteenth century or portions of the electromagnetic spectrum in the twentieth century, laws setting aside areas of navigable airspace for airborne wind-energy development might constitute a cost-justifiable change to property rights in that space. Airborne turbines would float well above altitudes where birds normally fly and could be removed from airspace with relative ease and with seemingly minimal permanent impacts on the occupied area. Still, given the risks and challenges of granting private interests in commons resources highlighted above, policymakers will surely want to exercise care when creating private interests in high-altitude airspace to facilitate airborne wind-energy projects.

⁶⁴ The term “navigable airspace” generally encompasses all airspace exceeding five hundred feet above ground level. See 14 C.F.R. § 77.23 (2009). Private landowners can typically hold interests in airspace within five hundred feet of the earth’s surface.

⁶⁵ For a general description of airborne wind-turbine technologies, which are still in their infancy, see Jim Hodges, *An Answer to Green Energy Could Be in the Air*, NASA (Dec. 10, 2010), <http://www.nasa.gov/topics/technology/features/capturingwind.html> (describing the Langley Research Center’s grant-funded research on airborne wind turbines).

⁶⁶ While navigable airspace typically begins at 500 feet above the surface, 14 C.F.R. § 77.23, researchers are currently considering airborne, wind-turbine models that would float between 2,000 and 30,000 feet above the ground, well within the realm of navigable airspace. Hodges, *supra* note 65.

⁶⁷ For a more detailed description of wind turbine wake interference in the context of conventional wind-energy development, see generally Troy Rule, *A Downwind View of the Cathedral: Using Rule Four to Allocate Wind Rights*, 46 SAN DIEGO L. REV. 207, 208-09 (2009).

B. *Laws Converting Private Property into Commons Property*

Technological or social changes might also sometimes justify converting private property into publicly shared commons resources.⁶⁸ Although Demsetz is perhaps best known for his observations about how and when private-property rights emerge out of a commons, his writings imply something more. One converse application of Demsetz's famous thesis is that sometimes *decreases* in the social value of an asset or *increases* in the cost of protecting property rights in it might actually justify extinguishing property protection and allowing the asset to fall back into the public trust for common use by all.⁶⁹

Laws governing some forms of intellectual property feature provisions that are expressly aimed at providing this unusual type of property-rights adjustment. Intellectual property laws generally allow copyrighted works to fall into the public domain or patents to expire after a specific term of years.⁷⁰ As Demsetz may have predicted, these laws seem based in part on the notion that the value of intellectual property often declines over time, gradually reducing the net social benefit of protecting such rights through costly property regimes.⁷¹

For analogous reasons, federal laws enacted in the 1930s also theoretically converted property rights in high-altitude airspace into commons resources in response to technological advancements in aviation. Prior to the era of modern flight, landowners' private airspace rights under the *ad coelum* doctrine had no definite endpoint, theoretically extending up "to the sky."⁷² When airplanes began traversing the airspace above hundreds of separately owned parcels in a single flight, rights to exclude in airspace

⁶⁸ Parenthetically, for readers particularly interested in this category of property-rights adjustments, one other example not set forth in this Article of a recent call for the conversion of private-property rights into commons ownership involves groundwater rights in the arid southwestern United States. See generally Danielle Spiegel, Comment, *Can the Public Trust Doctrine Save Western Groundwater?*, 18 N.Y.U. ENVTL. L.J. 412 (2010).

⁶⁹ Such instances are arguably distinguishable from cases in which property rights are effectively seized by government entities for their own enterprising use, like the FAA wind-farm restrictions described below. See *infra* Part IV.B.

⁷⁰ See Jiarui Liu, *Copyright Injunctions After eBay: An Empirical Study*, 16 LEWIS & CLARK L. REV. 215, 267 (2012) ("[T]he duration of copyrights is life plus 70 years, 95 years from publication, or 120 years from creation, as opposed to 20 years from application for patents." (footnote omitted)).

⁷¹ Such social gains include gains associated with protecting artists' incentives to create new works. These gains theoretically diminish once an artist has captured enough value to incentivize future creations. See Kate O'Neill, *'Should I Stay or Should I Go?—Covenants Not to Compete in a Down Economy: A Proposal for Better Advocacy and Better Judicial Opinions*, 6 HASTINGS BUS. L.J. 83, 103 n.32 (2010) ("Ideally, if not in practice, the temporary monopoly afforded by copyright or patent law should be just enough to ensure that the author or inventor has an incentive to create or invent but not so much that the public is deprived of access to the work or invention, or to derivatives of it, longer than necessary to provide the author or inventor a reasonable return on his investment.").

⁷² See *supra* notes 11-14 and accompanying text.

quickly became more socially valuable. Courts and policymakers responded with legal rules designating high-altitude “navigable” airspace as a commons or “public highway” for air travel.⁷³ This clear designation of high-altitude airspace as a commons area enabled air travel to flourish by eliminating the threat of trespass claims or the unrealistic theoretical prospect of requiring airlines to collect countless airspace easements to complete their routes.⁷⁴

1. Some Questions to Consider Before Converting Private Property into a Commons Resource

Although placing private property into commons ownership can be justifiable in a narrow set of situations, there are some key questions worth considering before undertaking this rare type of property-rights adjustment. First, once the alleged conversion of private property into commons property is complete, will the general citizenry truly have open access to and use of the asset at issue? Anyone can create and market their own derivative works based on Mark Twain’s *The Adventures of Tom Sawyer*,⁷⁵ and any licensed pilot can generally pass through any navigable airspace.⁷⁶ However, a new policy that, in all practicality, would allow only a small group of citizens to use assets that were newly designated as commons property arguably would not fall into this category but would be an example of a redistribution of property rights of the nature described in Part IV.A below.

Second, would the proposed conversion to commons ownership unfairly deprive private-property holders of existing interests in ways that might not pass constitutional muster? As decades of regulatory takings jurisprudence have made clear, laws or government actions that effectively take private property for public use often require the payment of just compensation under the Takings Clause.⁷⁷ Even when there is no physical invasion of the property at issue or when the claimant retains some economically viable use of her land, courts may still find a compensable taking if the

⁷³ See generally 14 C.F.R. § 77.23 (2009); *United States v. Causby*, 328 U.S. 256 (1946).

⁷⁴ For a more detailed discussion of the initial designation of navigable airspace after the emergence of air travel, see generally Troy A. Rule, *Airspace in a Green Economy*, 59 UCLA L. REV. 270, 280-82 (2011).

⁷⁵ All of Mark Twain’s masterful novels are securely within the public domain. Lengthy lists of famous books and other works that are in the public domain are available online. See, e.g., *Cinemoose’s List of Famous Books in the Public Domain*, CINEMOOSE, <http://cinemoose.com/books-in-the-public-domain> (last visited Mar. 14, 2013).

⁷⁶ In fact, the scope of “navigable airspace” is even expanded in some cases within three nautical miles of airports to better accommodate air travel. See 14 C.F.R. §77.23.

⁷⁷ U.S. CONST. amend. V (“[N]or shall private property be taken for public use without just compensation.”).

claimant receives inadequate reciprocal benefits in return for lost property rights.⁷⁸

Third, could converting the resource to commons property ultimately lead to its overexploitation? The famous “tragedy of the commons” set forth by Garrett Hardin in 1968⁷⁹ is the concept that scarce resources that are communally shared are prone to overexploitation because individual users of the resource are underincentivized to consider the full social cost of their consumption or to preserve the resource for future use by society.⁸⁰ For resources that are susceptible to such commons tragedies, policymakers must be particularly cautious about conversion to a commons regime.

2. Should Lawmakers Convert Deep Subsurface Areas into Commons Property?

The sorts of questions just described will likely arise in the coming years as policymakers respond to calls to convert deep subsurface areas into some form of commons property to combat climate change. In the past few years, some have advocated converting deep subsurface pore space⁸¹ into government-owned or commons property to encourage carbon capture and storage (“CCS”) and other forms of development that could slow climate change.⁸² CCS is the capture of carbon dioxide gas—a byproduct of conventional electric power generation—and long-term storage of it in open spaces deep underground in an effort to prevent it from entering the atmos-

⁷⁸ As those familiar with regulatory takings law surely know, this possibility of a right to just compensation even in the absence of a physical invasion or deprivation of all economically viable use is found under the test set forth in *Penn Central Transportation Co. v. New York City*, 438 U.S. 104, 130-31 (1978). For the U.S. Supreme Court’s own concise summary of the famous “*Penn Central* test” for potential takings liability outside of the two scenarios enumerated above, see generally *Lingle v. Chevron U.S.A. Inc.*, 544 U.S. 528, 538-39 (2005).

⁷⁹ See generally Garrett Hardin, *The Tragedy of the Commons*, 162 SCIENCE 1243 (1968).

⁸⁰ See Michael A. Heller, *The UNE Anticommons: Why the 1996 Telecom Reforms Blocked Innovation and Investment*, 22 YALE J. ON REG. 275, 278 (2005).

⁸¹ A relatively recent Wyoming statute defines “pore space” as “subsurface space which can be used as storage space for carbon dioxide or other substances.” WYO. STAT. ANN. § 34-1-152(d) (2009). Similarly, North Dakota defines “pore space” as “a cavity or void, whether natural or artificially created, in a subsurface sedimentary stratum.” N.D. CENT. CODE § 47-31-02 (Supp. 2011).

⁸² See, e.g., Sprankling, *supra* note 10, at 1036-48 (suggesting that landowners’ private interests in the subsurface should cease at 1,000 feet below the ground); see also Kevin L. Doran & Angela M. Cifor, *Does the Federal Government Own the Pore Space Under Private Lands in the West? Implications of the Stock-Raising Homestead Act of 1916 for Geologic Storage of Carbon Dioxide*, 42 ENVTL. L. 527 (2012) (arguing that the federal government owns the pore space under private lands patented under the Stock-Raising Homestead Act of 1916); James Robert Zadick, Note, *The Public Pore Space: Enabling Carbon Capture and Sequestration by Reconceptualizing Subsurface Property Rights*, 36 WM. & MARY ENVTL. L. & POL’Y REV. 257, 273 & n.126 (2011) (“[A]malgamation of pore space rights th[r]ough either private purchase or the exercise of eminent domain represents a fundamental obstacle to CCS development.”).

phere and contributing to the greenhouse effect.⁸³ Although CCS does not directly involve the generation of energy, it has a potential to play a role in the nation's future energy strategy by mitigating some of the environmental consequences of energy generation.

Laws designating pore space below a particular depth as a commons—comparable to the designation of navigable airspace as a “public highway” for air travel—could go far in promoting CCS. The large subsurface areas targeted for CCS often stretch below numerous separately owned parcels.⁸⁴ As at least one commentator has suggested, a rule requiring developers of CCS projects to obtain property interests from the owners of all such parcels would arguably be analogous to requiring airlines to acquire aviation easements across all of the airspace that they plan to cross during a flight.⁸⁵ In both instances, high transaction costs would severely hamper an important and socially valuable activity.⁸⁶ And so long as the distance from the earth's surface is great enough, the negative impacts on surface owners from both air flight and CCS are relatively low.

Unfortunately, the arguments in favor of converting deep subsurface pore space to commons resources are not nearly as clear cut as they were for navigable airspace. Pore space would not truly serve as any sort of “public highway” and arguably would not truly be communally shared.⁸⁷ Although ordinary landowners may theoretically benefit from CCS along with the planet's other seven billion inhabitants,⁸⁸ laws declaring deep pore space as commons property for CCS would seem at least somewhat more tenuous under *Pennsylvania Coal*'s familiar “reciprocity of advantage” analysis than the rule reserving navigable airspace for air travel.⁸⁹ Most citizens travel by air at least occasionally, while a very small number would

⁸³ Stephanie M. Haggerty, Comment, *Legal Requirements for Widespread Implementation of CO₂ Sequestration in Depleted Oil Reservoirs*, 21 PACE ENVTL. L. REV. 197, 200-01 (2003), cited in Klass & Wilson, *supra* note 30, at 364 n.5.

⁸⁴ See Zadick, *supra* note 82, at 287 (suggesting that, in at least some instances, pore spaces used for storage of carbon dioxide gas could “extend across state lines and below hundreds, if not thousands, of surface land owners”).

⁸⁵ See *id.* at 271-72.

⁸⁶ *Id.* at 272-73 (citing one study as finding that “unitization of the requisite pore space estates (if found to belong to the surface owner), or potential liability related to subsurface trespass claims, could render CCS economically infeasible” (footnote omitted)).

⁸⁷ Other scholars have alluded to the material differences between navigable airspace and deep pore space in recent years. See, e.g., Klass & Wilson, *supra* note 83, at 388 (“[T]he case law in the area of subsurface rights is much more complicated than that involving airspace.”).

⁸⁸ See Sam Roberts, *U.N. Says 7 Billion Now Share the World*, N.Y. TIMES, Nov. 1, 2011, at A4.

⁸⁹ *Pa. Coal Co. v. Mahon*, 260 U.S. 393, 415 (1922); see also *Penn Cent. Transp. Co. v. N.Y.C.*, 438 U.S. 104, 140 (1978) (Rehnquist, J., dissenting) (noting that one of the considerations under the regulatory takings test should be whether those burdened by the challenged government action received “comparable reciprocal benefits” in connection with the action (in which case there is a weaker argument for just compensation) or whether certain citizens were “singled out and treated differently” than others).

ever directly engage in carbon storage. Such a property-rights adjustment would thus disproportionately burden owners in lands conducive to CCS, denying them just compensation for the use and occupation of their subsurface areas without providing any unique benefits to them in return. For these reasons, a law declaring all areas more than one thousand feet below the ground to be federally owned “public” property could invoke challenges under the Takings Clause.⁹⁰

Of course, transferring private-property rights into or out of publicly shared commons is just one of several possible ways of adjusting property rights to support an increasingly valuable resource use. The next Part discusses some even more controversial ways of restructuring property laws in pursuit of such a goal.

IV. RESHUFFLING EXISTING PROPERTY RIGHTS AMONG SPECIFIC PARTIES

Another group of strategies for adjusting property rights involves rules that effectively reallocate property rights in a resource to those citizens or government entities that make the favored use of it.⁹¹ Unless those who lose property interests under such laws are compensated for their losses, these policy approaches have a tendency to favor some citizens over others and to weaken the stability and predictability of property regimes and should be employed warily if at all.⁹²

⁹⁰ Professors Alexandra Klass and Elizabeth Wilson drew a similar conclusion in their recent article on this subject. Klass & Wilson, *supra* note 83, at 405-06 (noting that, although such a rule “would certainly facilitate the development of CCS by reducing acquisition costs associated with subsurface pore space, it would almost just as certainly invite takings challenges”).

⁹¹ It is worth parenthetically noting that, within the private, governmental, and commons property framework set forth in this Article, one can conceive at least four other adjustments to existing property-rights arrangements. For instance, a law that authorized the construction of naval facilities on what were formerly public coastal areas would effectively transfer property interests in publicly shared commons to a government entity. Conversely, a law requiring the decommissioning of such a naval base and restoration of such areas for public access and use would reverse such a transfer, converting a government entity’s property into a commons. Other sorts of laws might effectively transfer property interests from one government entity to another, such as from a local government to a state or federal government agency, or vice versa. Still other policies might effectively transfer property interests from a government entity to a private citizen, such as a conveyance of a government-owned parcel to a large corporation to attract a new major employer to a community. For brevity’s sake, analyses of these other four types of adjustments to property arrangements are omitted from this Article.

⁹² For a discussion of how substituting “liability-rule” protection for “property-rule” protection for a narrow set of entitlements relating to a resource can sometimes enable property arrangements to adjust to technological change while still largely respecting existing entitlements, see *infra* Part V.B.

A. *Laws that Reallocate Existing Property Rights Among Private Citizens*

Some well-intended laws try to protect or promote a particular type of resource use by allowing citizens to unilaterally acquire private-property interests from others simply by using the resource in some favored way. The following are relatively recent examples of this type of policy arising in the context of small-scale solar-panel installations and of hydraulic fracturing for oil and gas.⁹³

1. *Laws that Redistribute Airspace Rights to Promote Solar-Panel Installations*

Continuing a long legacy of controversy over sunlight-related property rights,⁹⁴ conflicts over solar access are again raising perplexing property law issues as solar-energy development spreads rapidly across the country. The U.S. solar-energy industry has experienced unprecedented levels of growth over the past several years. Total installed photovoltaic solar-energy capacity in the United States increased by an astounding 109 percent in 2011 alone.⁹⁵ Solar energy is appealing in that a solar-energy device can generate renewable electric power for decades without emitting greenhouse gases. Although new antidumping tariffs imposed on Chinese photovoltaic

⁹³ “Distributed” solar-energy development differs from utility-scale, solar-energy development in that all or most of the energy generated by distributed solar-energy systems is consumed on site. In contrast, centralized solar-energy facilities such as concentrated solar plants tend to produce larger amounts of power on an industrial scale for transmission and use elsewhere. Rooftop solar-panel installations are the quintessential type of distributed solar-energy development. See Garrick B. Pursley & Hannah J. Wiseman, *Local Energy*, 60 EMORY L.J. 877, 897-900 (2011) (describing several benefits of distributed renewable energy).

⁹⁴ The extent of landowners’ rights to sunlight access has oscillated over time in response to changes in technology. Under old English common law, a landowner could obtain a prescriptive easement to protect the flow of sunlight through an open window under the doctrine of ancient lights. In an era of artificial electric light, U.S. courts later rejected this doctrine. See Troy A. Rule, *Shadows on the Cathedral: Solar Access Laws in a Different Light*, 2010 U. ILL. L. REV. 851, 865-66 (2010) (describing the doctrine of ancient lights and its eventual demise); see also Sara C. Bronin, *Solar Rights*, 89 B.U. L. REV. 1217, 1257-60 (2009) (“American courts at first embraced the ancient lights doctrine . . . [but] by the late nineteenth century, the ancient lights rule had been rejected everywhere in this country, except in Louisiana.”).

⁹⁵ *U.S. Solar Energy Soared 109 Percent in 2011*, TECH JOURNAL (Mar. 15, 2012), <http://www.techjournal.org/2012/03/us-solar-energy-soared-109-percent-in-2011>. This explosive growth is attributable in part to global oversupply conditions that have driven down solar-panel prices and made solar-generated electricity more cost competitive with fossil-fuel-generated power. *Solar Market Insight Report 2012 Q1*, SOLAR ENERGY INDUS. ASS’N, <http://www.seia.org/research-resources/solar-market-insight-report-2012-q1> (last visited Mar. 14, 2013) (reporting significant decreases in installed per-watt prices for photovoltaic systems “due to the persistence of the global oversupply environment that the industry has faced since early 2011”).

panels in 2012⁹⁶ could increase U.S. solar-panel prices in the future and some programs that have been subsidizing the industry are already starting to be phased out,⁹⁷ the nation's total solar-energy-generating capacity is likely to continue to increase in the coming years.

Shade from nearby trees or structures can limit the amount of solar radiation striking solar-energy systems, thereby reducing their productivity.⁹⁸ Although landowners can take steps to prevent structures on their own parcels from shading their solar-energy systems, there is still a risk that trees or structures on neighboring properties could cause costly shading. This risk of neighbor shading and its potential impacts on the productivity of a solar-energy system can deter some landowners from investing to install solar-energy devices on their parcels.⁹⁹

Some state statutes seek to prevent the shading of solar-energy devices by providing that landowners who install such devices on their parcels can unilaterally obtain free easements through the airspace above neighboring properties to protect the devices from shading. Statutes in two states—Wyoming and New Mexico—rely on weak analogies between water and sunlight to characterize these airspace easement rights as “solar rights” and assert that landowners qualify for these new property rights through rules meant to resemble the prior appropriation doctrine under water law.¹⁰⁰ Under these well-intended statutes, a landowner can obtain solar rights by being the first to make “beneficial use” of the airspace above neighboring property to provide solar-access protection for an installed solar-energy system.¹⁰¹

Unfortunately, unlike prior appropriation laws for water, which create new private-water rights out of publicly shared commons resources,¹⁰² the

⁹⁶ Keith Bradsher & Diane Caldwell, *U.S. Slaps High Tariffs on Chinese Solar Panels*, N.Y. TIMES, May 18, 2012, at B1.

⁹⁷ For example, the U.S. Department of the Treasury's 1603 program, which provided partial reimbursement of solar-energy system installation costs in lieu of tax credits, expired on September 30, 2012. *1603 Program: Payments for Specified Energy Property in Lieu of Tax Credits*, U.S. DEP'T OF THE TREASURY (Mar. 4, 2013), <http://www.treasury.gov/initiatives/recovery/Pages/1603.aspx>. The federal production tax credits program for photovoltaic solar-energy installations is currently scheduled to expire at the end of 2016. 26 U.S.C.A § 48(c)(4)(C) (West 2009).

⁹⁸ In fact, at least one recent study involving photovoltaic solar panels suggests that the impacts of shading are “often underestimated because [photovoltaic] systems respond nonlinearly to shade.” See Conference Report, Photovoltaic Specialists Conference, *A Simple Non-Linear Model for the Effect of Partial Shade on PV Systems* (June 20-25, 2010).

⁹⁹ To review the Author's own detailed description and analysis of the solar-access problem, see generally Rule, *supra* note 94.

¹⁰⁰ *Id.* at 876-78.

¹⁰¹ See *id.*; WYO. STAT. ANN. § 34-22-103(b)(i) (2011).

¹⁰² See Gregory J. Hobbs, Jr., *Priority: The Most Misunderstood Stick in the Bundle*, 32 ENVTL. L. 37, 41 (2002) (explaining that “under prior appropriation law, water remains a public resource” but that “the states . . . create property rights for the use of this resource, and beneficial use is the basis, measure, and limit of these water rights”).

New Mexico and Wyoming solar rights statutes merely reshuffle existing private-property rights. The “solar rights” supposedly created by prior appropriation under such statutes are actually just uncompensated¹⁰³ restrictive easements across neighboring airspace that are tailored to benefit specific landowners with solar-energy systems.¹⁰⁴ Permit-based solar-access laws in a handful of other jurisdictions effectively facilitate the same uncompensated transfers of airspace rights.¹⁰⁵

Laws that redistribute airspace rights for the purpose of ensuring solar access may be effective at encouraging solar-panel installations, but they can often sacrifice economic efficiency in the process. Because the intensity of sunlight tends to be roughly the same throughout a community,¹⁰⁶ prohibiting trees or vertical construction in a residential or commercial neighborhood solely to protect solar access at a particular location often may not be the highest-valued use of airspace at issue. Growing shade trees in the airspace near a building can provide energy-related benefits of its own by significantly reducing air conditioning use during the heat of the summer,¹⁰⁷ and vertical construction in airspace can be useful in combatting urban sprawl.¹⁰⁸ Laws that give priority to solar-access protection over other possible airspace uses, even when it is not the highest-valued use of the space, undermine economic efficiency by leading to suboptimal use of the airspace at issue.¹⁰⁹ Such laws can also offend prevailing notions of fairness, going

¹⁰³ It should be noted that Iowa’s solar-access statute does require that compensation be paid to neighbors whose properties are restricted to protect sunlight access for a solar-energy system. For a more detailed discussion of Iowa’s unique approach to solar access, see generally Rule, *supra* note 94, at 891-93.

¹⁰⁴ See *id.* at 877.

¹⁰⁵ These statutes effectively prohibit neighbors from shading any solar-energy system described on a special permit granted by the state or local government. See, e.g., MASS. ANN. LAWS ch. 40A, § 9B (LexisNexis 2012); WIS. STAT. ANN. §66.0403(2) (West 2012) (applicable to shading by vegetation only).

¹⁰⁶ Solar radiation intensity does vary throughout the country, but substantial variations in solar resources generally occur on a more regional than local basis. To view dozens of solar resource maps for the United States, visit the National Renewable Energy Laboratory website at <http://www.nrel.gov/gis/solar.html> (last visited Mar. 14, 2013).

¹⁰⁷ See Sustainable Urban Landscape Information Series, *Energy Saving Landscapes*, REGENTS OF THE UNIV. OF MINN., <http://www.sustland.umn.edu/design/energysaving.html> (last visited Mar. 14, 2013) (explaining that “[a]pproximately half of unwanted heat in a house in the summer comes from the sun shining through the windows” and suggesting that trees strategically located so as to “[s]hade east and west windows in the summer, where most solar energy enters the house” could significantly reduce this heating effect).

¹⁰⁸ See Stephen T. Del Percio, Comment, *The Skyscraper, Green Design, & the LEED Green Building Rating System: The Creation of Uniform Sustainable Standards for the 21st Century or the Perpetuation of an Architectural Fiction?*, 28 ENVIRONS: ENVTL. L. & POL’Y J. 117, 135 (2004) (“A tall, energy-efficient building in an urban setting where most workers use mass transit may be less energy-intensive than a low, large-floor-plate building in a suburban setting”).

¹⁰⁹ For the Author’s full economic analysis of solar-access laws, see Rule, *supra* note 74, at 309-15.

against the general expectations of landowners. Given the problems just described, it is thus hardly surprising that at least one state has softened its statutory solar-access protections in recent years.¹¹⁰

2. Laws that Redistribute Subsurface Rights to Promote Hydraulic Fracturing

Legal rules that reshuffle existing property interests to promote a specific type of resource use might be emerging in the context of oil and gas drilling as well. At least one court in recent years has embraced rules that significantly weaken landowners' interests in subsurface areas to promote hydraulic fracturing for oil and gas.¹¹¹ Hydraulic fracturing, also commonly referred to as "fracing" or "fracking," involves the high-pressure injection of chemical-filled water and sand underground to fracture rock shale and release valuable energy resources that otherwise might not be commercially extractable.¹¹² The Independent Petroleum Association of America claims that fracking technologies have added seven billion barrels of crude oil and six hundred trillion cubic feet of natural gas to the nation's recoverable reserves.¹¹³

Although fracking in some form has been prevalent in the oil and gas industry for decades,¹¹⁴ its increasing use has drawn much more attention to it in recent years.¹¹⁵ Fracking can generate property-related disputes when

¹¹⁰ Specifically, California recently weakened its solar-access laws. Under a former version of California's Solar Shade Control Act, a landowner whose vegetation shaded a neighbor's solar panel could be sued for public nuisance, held criminally liable for such shading, and compelled to remove the offending vegetation. CAL. PUB. RES. CODE § 25982 (West 2009). A highly publicized neighbor dispute in Sunnyvale, California, provoked widespread public criticism of the Solar Shade Control Act. See Felicity Barringer, *Trees Block Solar Panels, and a Feud Ends in Court*, N.Y. TIMES, Apr. 7, 2008, at A14. This controversy ultimately led the California legislature to amend portions of the Act in 2008. See 2008 Cal. Stat. 65. Among other things, the amendments eliminated the possibility of criminal prosecution of shading parties and otherwise reduced the severity of remedies under the Act. See Scott Anders et al., "Hey, Your Tree Is Shading My Solar Panels": *California's Solar Shade Control Act*, 2 J. SUSTAINABLE REAL EST. 361, 368 (2010) (explaining that, prior to the amendment of California's Solar Shade Control Act, landowners whose trees shaded neighbors' solar panels could be criminally prosecuted for maintaining a public nuisance but that "[a]fter the Act's amendment, violations are no longer considered criminal"); see also CAL. PUB. RES. CODE § 25983 (providing that violations of the Act now constitute merely "a private nuisance").

¹¹¹ See generally *Coastal Oil & Gas Corp. v. Garza Energy Trust*, 268 S.W.3d 1 (Tex. 2008).

¹¹² See Christopher S. Kulander, *Environmental Effects of Petroleum Production: 2010-2011 Texas Legislative Developments*, 44 TEX. TECH. L. REV. 863, 869 (2012).

¹¹³ See INDEP. PETROLEUM ASS'N OF AM., supra note 6, at 1.

¹¹⁴ See *Garza*, 268 S.W.3d at 17 ("[H]ydraulic fracturing has been commonplace in the oil and gas industry for over sixty years.").

¹¹⁵ See, e.g., Jeremy Miller, *Of Hydraulic Fracturing and Drinking Water*, N.Y. TIMES (July 1, 2009, 4:30 PM), <http://green.blogs.nytimes.com/2009/06/30/of-hydraulic-fracturing-and-drinking-water>

water and chemicals injected under a parcel, or the subsurface fractures themselves, cross subsurface boundary lines into areas directly below neighboring parcels, arguably giving rise to trespass claims.¹¹⁶ Fracking can also damage the value of the pore space below neighboring parcels by filling it with water, sand and chemicals that make it less suitable for gas storage or CCS.¹¹⁷

Under the *ad coelum* doctrine cited above,¹¹⁸ an argument can be made that those engaged in fracking should be liable for damages they cause to neighboring subsurface areas through their fracturing of shale and injections of fluids and sand.¹¹⁹ Theoretically, such neighbors should hold exclusion rights that protect these areas from degradation. The fact that several states require utilities to pay just compensation to surface owners to use subsurface areas for the underground storage of gas bolsters claims that surface owners can legally prevent trespass in these areas.¹²⁰

However, recognizing that the enforcement of subsurface trespass claims in the context of fracking could hinder growth in the U.S. oil and gas industry, at least one court in recent years has refused to find trespass in such a situation.¹²¹ In *Coastal Oil & Gas Corp. v. Garza Energy Trust*,¹²² the Texas Supreme Court refused to recognize a trespass claim against a company that had injected fluid and proppants during a fracking operation that migrated across subsurface boundaries to areas beneath neighboring land.¹²³ One rationale for the court's holding seemed to be that the public policy

(noting that the use of hydraulic fracturing techniques "has increased recently as exploration of deep gas fields in places like the Marcellus Shale and Colorado's Roan Plateau has stepped up").

¹¹⁶ See Claey's, *supra* note 14, at 30 ("Prima facie, any unconsented entry of land is a trespassory wrong to the owner's property.").

¹¹⁷ See Thomas E. Kurth et al., *American Law and Jurisprudence on Fracing*, 47 ROCKY MTN. MIN. L. FOUND. J. 277, 293 (2010) (noting that the "insertion of fracing fluid and proppants" underground can interfere with the "use of pore space for activities such as gas storage or CO2 sequestration").

¹¹⁸ See *supra* note 11 and accompanying text.

¹¹⁹ At least one commentator has made such an argument. See, e.g., Aaron Stemplewicz, Note, *The Known "Unknowns" of Hydraulic Fracturing: A Case for a Traditional Subsurface Trespass Regime in Pennsylvania*, 13 DUQ. BUS. L.J. 219, 252 (2011) (advocating that Pennsylvania courts reject the Texas court's holding in *Garza* and instead recognize subsurface trespass claims in the context of hydraulic fracturing in Pennsylvania).

¹²⁰ At least eight states have enacted statutes that allow utilities to condemn subsurface areas to facilitate underground gas storage. For citations to and a brief discussion of these laws, see generally Gresham & Anderson, *supra* note 32, at 732.

¹²¹ See generally *Coastal Oil & Gas Corp. v. Garza Energy Trust*, 268 S.W.3d 1 (Tex. 2008).

¹²² 268 S.W.3d 1 (Tex. 2008).

¹²³ *Id.* at 10, 14.

interest in promoting greater gas extraction outweighed trespass concerns so no trespass claims should arise.¹²⁴

The development of legal rules to efficiently govern property conflicts associated with hydraulic fracturing is still in its embryonic stages. Numerous academic and other articles published over the past few years are wrestling with this difficult task, and there appears to be no consensus yet regarding how best to balance competing policy goals in this context.¹²⁵ If courts and policymakers, intent on encouraging fracking, opt not to protect landowners against the unauthorized fracturing of shale formations and pumping of chemicals, water, and sand into areas below their parcels, such an approach would arguably significantly degrade landowners' existing subsurface property rights. Somewhat like the solar rights laws described above, such a rule would reshuffle neighboring landowners' existing property rights to prevent subsurface trespass under the *ad coelum* doctrine.¹²⁶

B. *Laws Transferring Private-Property Rights to Government Entities*

Another, closely related method of adjusting property rights is to effectively redistribute valuable property interests to specific government entities. Any restriction on private property that is imposed solely as a way

¹²⁴ See *id.* at 16 (“[C]ommon law liability for a long-used practice essential to an industry is ill-advised and should not be extended absent a compelling need that the Legislature and Commission have ignored.”).

¹²⁵ Although it is not practical in this brief Article to fully summarize the ongoing academic debate over property rights and hydraulic fracturing, the following cited articles would provide any reader an adequate launching point for further exploration in this area. See, e.g., Patrick C. McGinley, *Regulatory Takings in the Shale Gas Patch*, 19 PENN. ST. ENVTL. L. REV. 193, 196 (2011) (applying regulatory taking analysis to issues associated with laws governing hydraulic fracturing and describing how “constitutional takings principles can, in limited circumstances and at the margins, limit shale gas regulation”); David E. Pierce, *Carol Rose Comes to the Oil Patch: Modern Property Analysis Applied to Modern Reservoir Problems*, 19 PENN. ST. ENVTL. L. REV. 241, 243-46 (2011) (encouraging academicians and policymakers to consider modern property concepts introduced by Professor Rose and others, including the idea of “limited commons property,” when formulating legal rules to govern hydraulic fracturing); David E. Pierce, *Developing a Common Law of Hydraulic Fracturing*, 72 U. PITT. L. REV. 685, 686, 699 (2011) (analyzing hydraulic fracturing from the property, tort, and contract perspectives and ultimately suggesting that “courts must accurately define the extraterritorial rights of [all] owners within the reservoir” communities where fracking takes place); Hannah Wiseman, *Beyond Coastal Oil v. Garza: Nuisance and Trespass in Hydraulic Fracturing Litigation*, 57 THE ADVOC. (TEXAS) 8, 9 (2011) (arguing that *Garza* disclaimed only one type of trespass claim for hydraulic fracturing and delineating several other possible trespass or nuisance claims that courts have not yet fully considered).

¹²⁶ It is worth noting that damages might still be available in tort in some instances if a court finds that the specific hydraulic fracturing activities that have injured or contaminated a neighbor's subsurface areas were unreasonable in nature, although it can be very difficult to establish unreasonableness in this context. See BOSSELMAN ET AL., *supra* note 18, at 270 (citing *Tidewater Oil Co. v. Jackson*, 320 F.2d 157 (10th Cir. 1963), as an example of a case applying this line of analysis to a secondary recovery operation involving subsurface waterflooding that drowned out a neighbor's oil well “within hours”).

of transferring rights in that property to a government entity for its own enterprising use should arguably trigger a regulatory takings claim under the Takings Clause.¹²⁷ Unfortunately, gaps in property law involving airspace and deep subsurface areas can sometimes allow government entities to impose such restrictions without having to compensate citizens for their losses.¹²⁸ Such laws may be able to withstand challenges under current takings jurisprudence, but they can still be problematic from a policy perspective, discouraging fair and efficient use of the resources involved.

In recent years, the Federal Aviation Administration (“FAA”) has leveraged its regulatory authority to effectively take private airspace rights for military use. The FAA has prohibited or delayed commercial wind farm development across hundreds of square miles of rural U.S. land solely to prevent interference with outmoded military radar systems.¹²⁹ The American Wind Energy Association claims that almost 50 percent of the generating capacity of all commercial wind-energy development proposed in the United States in 2009 was “abandoned or delayed because of radar concerns raised by the military and the [FAA].”¹³⁰ In some instances, the FAA has used its regulatory power to oppose wind farms situated up to sixty miles away from the nearest military base.¹³¹

Onshore wind turbines are typically less than five hundred feet tall, so they do not encroach into “navigable airspace”—the publicly shared space above that height that is generally reserved for air travel.¹³² When the FAA

¹²⁷ The Takings Clause prohibits governments from taking “private property . . . for public use, without just compensation.” U.S. CONST. amend V. The Fifth Amendment initially applied only to actions of the federal government, but it was also made applicable to state and local governments by virtue of the Fourteenth Amendment. STEVEN J. EAGLE, *REGULATORY TAKINGS* 4 (4th ed. 2009) (citing case law as evidence that the U.S. Supreme Court has long “interpreted the Takings Clause as applying to states and localities as well”). Such restrictions might also be susceptible to challenge under the Due Process Clause on the ground that they are not rationally related to promotion of the general health, safety, morals, or welfare of the citizenry. *See, e.g., Riggs v. Twp. of Long Beach*, 538 A.2d 808, 813 (N.J. 1988) (refusing to uphold a township’s denial of an application for subdivision of a private parcel because the denial was issued for the invalid zoning purpose of limiting the value of applicant’s land so that the township could acquire the land more cheaply through eminent domain), *cited in* ROBERT C. ELLICKSON & VICKI L. BEEN, *LAND USE CONTROLS: CASES AND MATERIALS* 133 (3d ed. 2005).

¹²⁸ For the Author’s full takings analysis of the FAA’s airspace restrictions and arguments that such restrictions should trigger a compensable taking, see generally Troy A. Rule, *Airspace and the Takings Clause*, 90 WASH. U. L. REV. 421 (2013).

¹²⁹ *See* Leora Broydo Vestel, *Wind Turbine Projects Run into Resistance*, N.Y. TIMES, Aug. 27, 2010, at B1.

¹³⁰ *See id.*

¹³¹ *See* Donald Zillman et al., *More Than Tilting at Windmills*, 49 WASHBURN L.J. 1, 17-18 (2009) (noting that the U.S. Department of Defense directed the FAA to distribute notices of “presumed hazard” to wind project contractors for sites located too close to long-range radar installations); *see also* Kate Galbraith, *Gulf Coast Wind Farms Spring up, as Do Worries*, N.Y. TIMES, Feb. 11, 2011, at A23A (stating that “the Navy would like wind farm construction to stay outside a 30-mile radius of its facilities”).

¹³² *See supra* note 66 and accompanying text.

prevents otherwise permissible wind farm development within private, nonnavigable airspace for the sole purpose of protecting use of that space by the U.S. Department of Defense (“DOD”), the FAA effectively transfers airspace rights from private parties to a government entity. In that sense, such restrictions should arguably constitute regulatory takings and entitle burdened citizens to just compensation.¹³³ However, these FAA restrictions likely are not compensable under current regulatory takings laws.¹³⁴ The risk of such uncompensated restrictions reduces the stability and certainty associated with property-rights ownership in rural airspace and undercuts incentives for productive investment in such space.¹³⁵

Laws allowing the FAA to restrict wind-energy development solely to benefit a specific military base not only weaken property interests—they can also result in suboptimal use of the resources affected. Interference problems between wind farms and military radar are often avoidable through relatively inexpensive and readily available upgrades to outmoded radar systems.¹³⁶ In fact, the United Kingdom has even purchased such upgrades from U.S. manufacturers in recent years.¹³⁷ When the social value of a proposed wind farm exceeds the cost of upgrading a military base’s radar system, the military should upgrade the system and the wind farm project should proceed. Unfortunately, the DOD, acting out of self-interest, has little incentive to consider such upgrades so long as the FAA is willing to oppose wind farms on the DOD’s behalf and no payment of just compensation is required for such restrictions.

V. LIABILITY RULES: ONE WAY TO MORE EQUITABLY AND EFFICIENTLY ADJUST PROPERTY RIGHTS?

Not surprisingly, no single policy strategy or theory seems capable of resolving all of the complicated issues now emerging at the intersection of property law and modern energy law. Merely clarifying existing property arrangements cannot adequately address such challenges in many contexts, meaning that more substantial changes are sometimes necessary to prevent existing arrangements from hindering important social progress. On the other hand, as described in Parts III and IV above, policies that effectively disregard longstanding property-rights regimes and redistribute or recharac-

¹³³ See Rule, *supra* note 128.

¹³⁴ For the Author’s own takings analysis of these restrictions, see generally *id.*

¹³⁵ The same sort of critique is made above with regard to policies that merely reshuffle property interests among private citizens. See *supra* Part V.A.

¹³⁶ For more information on the approach of upgrading outmoded radar systems to resolve conflicts between military radar and wind farms, see Rule, *supra* note 128 (manuscript at 10-12).

¹³⁷ See Robert Mendick, *Military Radar Deal Paves Way for More Wind Farms Across Britain*, THE TELEGRAPH, Aug. 27, 2011, <http://www.telegraph.co.uk/earth/energy/windpower/8726922/Military-radar-deal-paves-way-for-more-wind-farms-across-Britain.html>.

terize property interests to promote particular energy strategies can create problems of their own. In these complex situations, what other strategies may be available to assist policymakers in their efforts to preserve stable property rights while still adapting property law to the challenges of the twenty-first century energy industry?

All else equal, the most fair and efficient ways of adjusting property regimes in response to energy innovation are those that facilitate such innovation while still respecting citizens' long-established property interests. This Part draws attention to just one type of strategy for balancing these two policy goals: replacing "property-rule" protection with "liability-rule" protection for certain narrowly defined entitlements in the scarce resources involved.

A. *An Overarching Principle for Adjusting Property-Rights Regimes: Respect Parties' Existing Entitlements*

In the property law context, an "entitlement" is "any legal right or protected interest"¹³⁸ that gives its holder certain defined rights vis-à-vis others.¹³⁹ Judge Guido Calabresi and Douglas Melamed embedded the concept of entitlements deeply into property theory with their influential law review article in 1972.¹⁴⁰ Property laws often assign entitlements by defining the scope and extent of rights and property interests associated with scarce assets.¹⁴¹ Ideally, policymakers take economic efficiency, distributional goals, and other valid reasons into account so as to make such initial assignments in ways that promote the social welfare.¹⁴² However, generally speaking,

¹³⁸ JOSEPH WILLIAM SINGER, ENTITLEMENT: THE PARADOXES OF PROPERTY 91 (2000).

¹³⁹ Common examples of entitlements in this sense include "[t]he entitlement to make noise versus the entitlement to have silence, [and] the entitlement to pollute versus the entitlement to breathe the clean air," although countless other interests can be similarly framed as entitlements. Guido Calabresi & A. Douglas Melamed, *Property Rules, Liability Rules, and Inalienability: One View of the Cathedral*, 85 HARV. L. REV. 1089, 1090 (1972).

¹⁴⁰ See generally *id.*; see also Brian M. Hoffstadt, *Dispossession, Intellectual Property, and the Sin of Theoretical Homogeneity*, 80 S. CAL. L. REV. 909, 942 (2007) (explaining that the entitlements concept set forth in Judge Guido Calabresi and Professor Douglas Melamed's article "established a new and influential approach to evaluate the utilitarian efficacy of property law"). It should be noted that Ronald Coase is commonly cited for his observation that the establishment of clear entitlements in scarce resources promotes allocative efficiency by reducing transaction costs and encouraging exchanges that can enable resources to flow to their highest-valued uses. See generally Coase, *supra* note 48.

¹⁴¹ Calabresi and Melamed suggest this in their article. Calabresi & Melamed, *supra* note 138, at 1105 ("In our framework, much of what is generally called private property can be viewed as an entitlement which is protected by a property rule.").

¹⁴² See *id.* at 1093-1105 (describing "economic efficiency, distributional preferences, and other justice considerations" as three groups of rationales for how to make initial assignments of entitlements).

once such initial assignments are set, “society must enforce that choice.”¹⁴³ In other words, courts and legislators should resist reshuffling previously assigned entitlements. To otherwise allow such reshuffling can not only offend basic notions of fairness but can breed legal uncertainty capable of undermining parties’ incentives to maximize the entitlements’ productive value.

As Ronald Coase famously observed, in the absence of transaction costs, laws that establish clear entitlements in scarce resources promote allocative efficiency by enabling and incentivizing parties to bargain among themselves to allocate the resources to their highest valued use regardless of to whom the entitlements are initially assigned.¹⁴⁴ Unfortunately, for some energy resources the transaction costs generally associated with such Coasean bargaining greatly exceed zero. For example, one of two parties competing for a particular asset simply may not be in the mood to strike a deal.¹⁴⁵ Or, such a large number of parties may be implicated that collective action problems make striking a deal close to impossible. Transaction costs such as these can be roadblocks to efficient Coasean bargains, even when property rights are crystal clear.¹⁴⁶

B. *Liability Rules as a Way of Balancing Stability and Adaptability in Property and Energy Law*

One way to mitigate these transaction cost problems is to protect property rights in the assets at issue through what Calabresi and Melamed famously referred to as “liability rules” rather than “property rules.”¹⁴⁷ Most property entitlements are protected with property rules.¹⁴⁸ Property-rule protection means that other parties can acquire the entitlement only by purchasing it in a voluntary transaction at a price acceptable to its holder.¹⁴⁹ When an entitlement is protected instead by a liability rule, parties other

¹⁴³ *Id.* at 1090.

¹⁴⁴ See Coase, *supra* note 48, at 15 (noting that, in the absence of transaction costs, transactions over clearly assigned entitlements “will always take place if [they] will lead to an increase in the value of production”).

¹⁴⁵ This is sometimes referred to as the “bilateral monopoly” problem. See generally Abraham Bell, *Private Takings*, 76 U. CHI. L. REV. 517, 530 (2009) (describing the bilateral monopoly problem in the context of bargaining over a property right).

¹⁴⁶ For a discussion of transaction costs in the context of Coasean bargaining, including the bilateral monopoly and collective action problems just described, see generally James E. Krier & Stewart J. Schwab, *Property Rules and Liability Rules: The Cathedral in Another Light*, 70 N.Y.U. L. REV. 440 (1995).

¹⁴⁷ See generally Calabresi & Melamed, *supra* note 139.

¹⁴⁸ Richard A. Epstein, *A Clear View of The Cathedral: The Dominance of Property Rules*, 106 YALE L.J. 2091, 2095-96 (1997).

¹⁴⁹ Calabresi & Melamed, *supra* note 139, at 1092.

than the entitlement holder effectively hold options to purchase the entitlement at its objective value as determined by some governmental third party.¹⁵⁰

Legal academics have been debating for years the relative benefits of property-rule and liability-rule protection.¹⁵¹ In the words of Professor Stewart E. Sterk, property-rule protection is often appealing because of its propensity for “encouraging investment, facilitating market exchange, and protecting [an asset’s] subjective value.”¹⁵² However, even the strongest advocates of property-rule protection concede that it can generate “unacceptable inefficiencies” in some situations.¹⁵³ Professor Henry Smith has specifically noted the potential advantages of using liability rules “to fine-tune basic exclusionary regimes in high-stakes contexts.”¹⁵⁴ In particular, liability-rule protection can better promote efficiency in instances where imperfect information, holdout problems, free-rider problems, or other barriers are likely to impede the Coasean bargaining necessary to allocate scarce resources to their highest valued uses.¹⁵⁵

1. Former and Existing Policy Strategies Involving Liability-Rule Protection

For centuries, policymakers have been substituting liability-rule protection for property-rule protection for particular assets or in particular situations to promote and facilitate energy development. The eighteenth-century mill dam statutes referenced in the introduction to this Article are one example of such an approach.¹⁵⁶ To promote watermill-generated energy, these laws allowed mill owners to flood neighboring properties when reasonably necessary in their mill operations.¹⁵⁷ However, the laws required that mill owners compensate their neighbors for damages caused by such flooding, thereby respecting neighbors’ existing entitlements to flood-free land.¹⁵⁸ Compulsory unitization laws also effectively substitute liability rules for property rules as a way of overcoming holdout problems and other transaction costs while still promoting equity and fairness in fossil-fuel extraction. Under such laws, landowners within field boundaries are effective-

¹⁵⁰ *See id.*

¹⁵¹ For a fairly recent summary of the scholarly debate on the relative advantages of property rules and liability rules, see generally Stewart E. Sterk, *Property Rules, Liability Rules, and Uncertainty About Property Rights*, 106 MICH. L. REV. 1285 (2008).

¹⁵² *Id.* at 1335.

¹⁵³ *Id.* (citing Epstein, *supra* note 148, at 2110).

¹⁵⁴ *See* Smith, *supra* note 15, at 980.

¹⁵⁵ *See* Calabresi & Melamed, *supra* note 139, at 1106-10.

¹⁵⁶ *See supra* note 2 and accompanying text.

¹⁵⁷ 1795 MASS. ACTS. 443-44.

¹⁵⁸ *Id.*

ly compelled to sell off their oil and gas interests so that the underlying resource can be extracted fairly and efficiently.¹⁵⁹

The government's eminent domain power is yet another obvious example of a policy that allows for substitution of liability-rule protection for property-rule protection under certain circumstances to promote the social good. Eminent domain authority effectively gives qualifying government entities options to purchase property entitlements from private citizens, enabling such entities to avoid holdout problems and other transaction costs that would otherwise greatly increase the cost of government-provided infrastructure.¹⁶⁰ At the same time, citizens' right to just compensation under eminent domain law respects citizens' existing property entitlements, thereby substantially diminishing the financial risk associated with having land condemned.¹⁶¹

2. Liability Rules and the Next Generation of Energy Strategies

Might substituting liability-rule protection for property-rule protection be a way of addressing some of the property conflicts raised by modern energy? Although such an approach is no panacea, it can be useful in some circumstances and thus deserves consideration as policymakers wrestle with property and energy issues in the coming decades.

Iowa's solar-access statute is a prime example of how a liability-rule approach can respect existing property interests while still promoting sustainable energy practices.¹⁶² Iowa's law provides that landowners who install solar panels on their properties but are unable to negotiate solar-access easements with southerly neighbors can ultimately compel neighbors to sell them such easements for a reasonable price determined by a government entity.¹⁶³ This approach overcomes the problem of failed bargaining while

¹⁵⁹ For a brief description of laws facilitating field unitization, see *supra* note 3 and accompanying text.

¹⁶⁰ See Erin Ryan, *Federalism at the Cathedral: Property Rules, Liability Rules, and Inalienability Rules in Tenth Amendment Infrastructure*, 81 U. COLO. L. REV. 1, 17 (2010) ("[T]he liability rule ensures that a socially desirable transaction may proceed even if the entitlement holder protests—as does the law of eminent domain, which enables the government to condemn land for highways and airports by paying fair market value even if one or more of the owners of targeted properties would rather not sell." (footnote omitted)).

¹⁶¹ See Susan Rose-Ackerman & Jim Rossi, *Disentangling Deregulatory Takings*, 86 VA. L. REV. 1435, 1480 (2000) ("When eminent domain is used, payment of compensation at market rates gives property owners the incentive to invest based on estimates about future market conditions without also having to guess the likelihood that the state will seize their assets.").

¹⁶² See IOWA CODE ANN. § 564A (West 1992). For the Author's full "Cathedral" analysis of the solar-access problem and greater discussion of Iowa's statutory approach, see generally Rule, *supra* note 94.

¹⁶³ IOWA CODE ANN. § 564A.5.

still acknowledging neighbors' property interests in the airspace above their land.

A liability rule-based approach comparable to that for field unitization might also be appropriate to govern conflicts over shale fractures from hydraulic fracturing operations that extend below neighboring landowners' properties. Such rules could make clear that fracking does not give rise to actionable trespass or nuisance claims but could nonetheless provide for some sort of financial benefit to each landowner whose subsurface is involved. One could conceive of a similar sort of approach for facilitating CCS that allowed those engaged in CCS to unilaterally obtain rights to store carbon dioxide in neighbors' subsurface pore space upon payment of fair market value for the use of that space. Policies that protected property interests in these subsurface areas with liability rules would allow responsible CCS and fracking operations to proceed while respecting neighboring landowners' subsurface rights. The state condemnation statutes for underground gas storage mentioned earlier already provide a form of such liability-rule protection in the context of subsurface storage of natural gas.¹⁶⁴ Laws that required the payment of just compensation for the types of airspace restrictions described in Part IV.B above would be yet another example of a liability-rule approach that better respected existing property entitlements. Such laws would still allow military entities to secure private airspace rights for their own use but would require them to pay for the space that they take.

Admittedly, liability rule-based policies have their own drawbacks, including their comparatively high administrative costs and the potential difficulties of accurately valuing the resources at issue.¹⁶⁵ Still, in the contexts just described and in similar situations,¹⁶⁶ liability rules at least deserve consideration as one possible way of encouraging and facilitating important new forms of development without disregarding existing property interests.

CONCLUSION

As the United States continues its transition toward more sustainable energy practices, property laws will continue to evolve in response to these changes. Clear property-rights regimes that are carefully tailored to the specific attributes of the resource at issue can do much to encourage progress

¹⁶⁴ See *supra* note 120.

¹⁶⁵ Legal scholars have identified numerous costs and potential disadvantages associated with liability-rule policies. For a general introduction to some common criticisms of liability rules and citations to sources with more details on this topic, see generally Louis Kaplow & Steven Shavell, *Property Rules Versus Liability Rules: An Economic Analysis*, 109 HARV. L. REV. 713, 728-32 (1996).

¹⁶⁶ Liability rules could even be a useful way of addressing disputes over wind-turbine wake interference. For the Author's detailed analysis of wind-turbine wake interference conflicts and the possibility of tailored laws involving liability rules to address them, see generally Rule, *supra* note 67.

toward a more sustainable energy future. When social or technological changes raise new questions about the scope of property rights, merely clarifying those rights is often an adequate legislative or judicial response. However, as this Article suggests, sometimes mere clarifications of existing law are not enough to promote important new energy strategies, suggesting that additional policy actions are needed. In these settings, courts and policymakers must be cautious not to unfairly or inefficiently redistribute existing property interests in their effort to promote new forms of energy development. Policies that substitute liability-rule protection for property protection for particular, narrowly defined assets have proven capable of providing flexibility and adaptability for property arrangements in the past, so such policies are at least worthy of consideration as policymakers seek to adapt property law to the realities of the modern energy sector. Just as engineers and scientists are building upon knowledge amassed over centuries of research to develop technological breakthroughs that advance the cause of energy sustainability, policymakers and legal academics should also draw on past experience to help advance property law in ways that ensure a stable, sustainable energy future for generations to come.