WIND TURBINE WAKES, WAKE EFFECT IMPACTS, AND WIND LEASES: USING SOLAR ACCESS LAWS AS THE MODEL FOR CAPITALIZING ON WIND RIGHTS DURING THE EVOLUTION OF WIND POLICY STANDARDS

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INTRODUCTION

Wind rights and access to natural wind flow raise important legal issues, policy questions, opportunities, and financial risks for landowners, their neighbors, and for wind facility developers. This is particularly evident with respect to the phenomenon called wake effect (downwind effect) that occurs between commercial upwind turbines and downwind turbines. Upwind turbines create wind wakes that impact the natural wind flow to adjacent downwind turbines, causing the downwind turbines to experience diminished energy production and, in some cases, increased mechanical loads. The rights and income streams that are tied to this diminution can influence a developer's decision to erect turbines in certain locations or to construct a wind project altogether. At a minimum, for wind projects that are constructed, developers and landowners on whose property commercial wind turbines are placed should consider the impact of wake effect on turbine placement, operation, and performance.

The United States currently lacks a comprehensive national standard, federal guidelines, legislation, Supreme Court precedent, or a regulatory structure that establishes a unified approach to wind rights, including a uniform minimum setback distance (the length of

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the buffer zone between two utility-scale wind turbines, or between a utility-scale wind turbine and the adjacent landowner's property line). Through the example of wake effect, this article argues that a non-unified approach to wind rights as a matter of policy is not optimal for several reasons. First, as discussed herein, inconsistent laws, rules, and regulations across state lines and between local jurisdictions—such as the absence or presence of setback distances between wind turbines—factor into the magnitude of adverse economic impacts a downwind turbine owner may sustain, particularly in terms of potential financial loss due to turbine spacing and location on a particular parcel. Second, inconsistency between jurisdictions may encourage developers to forum shop for the jurisdiction that has the most favorable laws, rules, and regulations, depending on whether their respective turbines will be located upwind or downwind of another developer's turbines in a particular location.

A more preferable approach would be to adopt a more unified policy that encourages wind turbine construction on a site on which feasibility, environmental, and other suitability studies have been conducted, regardless of whether or not that site is upwind or downwind from an adjacent developer's wind farm site. Currently, the legal policies and regulations governing wind rights in a particular area influence how developers address wind flow over a particular parcel, wake effect, cumulative impact issues, turbine siting, wind lease negotiation, and constraints to wind farm development. Accordingly, states with suboptimal regulations with respect to wind farm development and, specifically, a minimum turbine setback distance, may lose the wind project and the accompanying revenue to other states having shorter minimum setback distance requirements or no setback restrictions at all. For instance, one state may lose to another state the jobs that are created by and accompany wind farm construction which would otherwise have been a source of economic stimulation for the area at and around the wind farm site. The issue of statutes and ordinances establishing setback limits then becomes a political and economic issue rather than a renewable energy or environmental issue. Not surprisingly, significant economic and political consequences flow from decisions governing turbine setback limits, and from developers' decisions as to where and whether a wind farm should be sited in a particular city, county, or state. Developing an appropriate legal and regulatory framework that simultaneously sets desirable policy standards for developers, states, landowners, and the general public, and that maximizes both wind farm productivity and profitability is critical.

Determining the precedent and the most appropriate theoretical basis behind this framework is of paramount importance. Applying case law and other legal precedents founded on litigation-based legal theories invites confrontation between parties and may not be the best approach for resolving wake-effect-based disputes between upwind and downwind developers. Developers should not automatically be perceived as adversaries with landowners, the local community, or other significantly impacted stakeholders, particularly because community buy-in and support is essential to the development of a wind farm project. While wind lease agreements between developers and landowners may grant certain rights to each, such as non-obstruction easements to the developers and royalty payments to landowners, these bilateral contracts generally do not involve other stakeholders or entail community input, making these contracts and the wind rights negotiation process inherently non-transparent. As a compounding consideration, current state regulations, such as those in Minnesota and North Dakota, create a piecemeal framework for determining incentives, liability, and transparency in wind lease agreements.[1]

Lessons learned from other countries' case law are instructive insofar as selecting the appropriate precedent and rationale on which a U.S. domestic legal framework for wind rights may be based. Japan and Great Britain each have case law and other precedent with respect to sunlight access. Because sunlight and wind access share common elements, this article advocates employing regulatory paradigms used to govern solar rights in Japan and Great Britain—in addition to elements of solar access laws from certain domestic states—as a viable approach and foundation for laws and policies governing wind rights.[2] Historical precedent both domestically and abroad illustrates that contemporary social factors and economic considerations play critical roles in shaping policy and impacting courts' rationales for determining ownership rights to access natural

1. *See infra* Part V.E.; *see, e.g.*, Next Generation Energy Act, 2007 Minn. Laws ch. 136 (S.F. No. 145); H.B. 1509, 61st Leg. Assem., Reg. Sess. (N.D. 2009) (codified at N.D. CENT. CODE § 17-04-06 (2011)).

2. *See infra* Part III.C.–IV.; *see, e.g.*, Building Standard Law Amendment No. 35 of 1978, Law No. 86 (Nov. 15, 1976) (Japan); Rights of Light Act of 1959, 7 & 8 Eliz. 2, c. 56, § 1–8 (Eng.); Solar Rights Act, N.M. Stat. Ann. §§ 47-3-1 to 47-3-5 (1978); Solar Shade Control Act, Cal. Pub. Res. Code §§ 25980–25986 (2010).

resources such as sunlight. Today, these same policy-shaping factors may impact wind rights allocation in this evolving area of law. This article proposes a new approach for determining wind rights by analogizing wind to sunlight, and by encouraging substantially impacted stakeholders and directly impacted communities to participate in the wind rights allocation process. This approach offers a springboard for formulating new legal policies and advancing the development of state, regional, and federal wind rights standards.

I. WAKE EFFECT

A. Background on U.S. Wind Energy Development and Wake Effect

In 2010, the total installed generating capacity of wind energy in the United States reached over 40,000 megawatts (MW—the equivalent of one million watts).[3] As of the end of the third quarter of 2011, an additional 3,360 MW of wind power capacity was installed, bringing the cumulative United States wind power capacity to 43,461 MW.[4] This increase was due, in part, to tax incentives from the American Recovery and Reinvestment Act of 2009,[5] state renewable portfolio standards,[6] and increased public acceptance of renewable energy projects.[7] While the development of wind energy facilities

3. AMERICAN WIND ENERGY ASS'N, U.S. WIND INDUSTRY YEAR-END 2010 MARKET REPORT 1 (2011) [hereinafter, AWEA MARKET OUTLOOK], http://www.awea.org/learnabout/publications/upload/4Q10_market_outlook_public.pdf.

4. *Industry Statistics*, AMERICAN WIND ENERGY ASS'N, http://www.awea.org/learnabout/industry_stats/index.cfm (last visited Nov. 18, 2011).

5. Pub. L. No. 111-5, 123 Stat. 115, 516 (2009).

6. *See generally* CTR. FOR CLIMATE & ENERGY SOLUTIONS, RENEWABLE AND ALTERNATIVE ENERGY PORTFOLIO STANDARDS (2011), http://www.pewclimate.org/sites/default/modules/usmap/pdf.php?file=5907. Specifically, while most states have a mandatory renewable portfolio standard (RPS), other states have alternative energy portfolio standards, while still others have renewable or alternative energy goals. North Dakota, South Dakota, Utah, Virginia, Oklahoma, Indiana, and Florida are examples of states that have set voluntary alternative energy goals, rather than mandatory requirements, for renewable energy targets. *Id.*; *States with Renewable Portfolio Standards*, U.S. DEP'T OF ENERGY, ENERGY EFFICIENCY AND RENEWABLE ENERGY, apps1.eere.energy.gov/states/maps/renewable_portfolio_states.cfm#map (last visited Dec. 20, 2011). Under a state RPS, electricity providers in a particular state are required to derive a minimum threshold percentage of their power from renewable energy by a certain year in the future. *See id.*

7. *See Public Acceptance of Renewable Energy*, ECOLOGIC INSTITUTE, http://ecologic.eu/1526 (last visited Dec. 20, 2011). Absent public support, particularly at the local level, the following can last for a protracted period: planning and permitting process, the stakeholder consultation process, the overall process for obtaining all mandatory developmental consents, and the process of conducting all necessary studies to a satisfactory extent. *Id.*

spurred extensive growth in manufacturing and industry jobs,[8] some landowners and developers faced considerable challenges related to the siting of wind projects, including conducting feasibility studies to ensure that the target site satisfies certain criteria making it suitable for turbine siting and licensing of new wind projects adjacent to existing projects.[9] As of January 2011, fourteen states had over one gigawatt (GW—the equivalent of one billion watts) of installed wind energy generating capacity, and thirty-eight states had utility-scale wind facilities.[10]

B. Wake Effect Defined

The term "wake effect" originates from the wake behind a ship. Ship wakes are generally three ship-lengths long and include two phenomena: (1) a turbulent wake, which forms directly behind the ship, and (2) a Kelvin wake, which is wedge-shaped, starts from the ship's hull, and fans out behind the ship; the Kelvin wake is bisected by the turbulent wake.[11] Like ships, wind turbines also create wakes.[12] In contrast to a ship-generated wake, however, a wind turbine wake is a long trail of turbulent wind exiting the turbine with diminished wind speed.[13] For wind turbines, wake effect relates to the wind speed deficit and diminished energy content wind possesses after leaving a particular utility-scale wind turbine. Wind turbines generate power by converting the kinetic energy in wind into electricity.[14] As wind flows through a turbine, the volume of air downwind of the turbine has a lower wind speed and higher turbulence than wind in the freestream.

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8. JAMES HAMILTON & DREW LIMING, U.S. BUREAU OF LABOR STAT., CAREERS IN WIND ENERGY 1–4, 18 (2010), *available at* www.bls.gov/green/wind_energy/wind_energy.pdf.

9. *See* AMERICAN WIND ENERGY ASS'N, WIND ENERGY SITING HANDBOOK 2-2 to 2-5 (2008), *available at* http://www.awea.org/sitinghandbook/; J.F. MANWELL ET AL., WIND ENERGY EXPLAINED: THEORY, DESIGN, AND APPLICATION 408 (2d ed. 2009).

10. AWEA MARKET OUTLOOK, *supra* note 3, at 4 (listing states with greater than one GW of installed wind capacity as Texas, Iowa, California, Washington, Minnesota, Oregon, Illinois, New York, Colorado, North Dakota, Oklahoma, Wyoming, Indiana, and Kansas).

11. Christian Melsheimer, *Ship Wakes Observed with ERS and SPOT*, CRISP RESEARCH, http://www.crisp.nus.edu.sg/~research/shipwakes/shipwakes.htm (last visited Dec. 20, 2011).

12. DANISH WIND INDUSTRY ASS'N, GUIDED TOUR ON WIND ENERGY 56 (2002), *available at* http://www.heliosat3.de/e-learning/wind-energy/windpowr.pdf.

13. *Id.*

14. MANWELL ET AL., *supra* note 9, at 91, 205, 423; REBECCA J. BARTHELMIE ET AL., VERIFICATION OF AN EFFICIENCY MODEL FOR VERY LARGE WIND TURBINE CLUSTERS, INTRODUCTION (2005) [hereinafter BARTHELMIE ET AL., TURBINE CLUSTERS], *available at* http://wind.nrel.gov/public/SeaCon/Proceedings/Copenhagen.Offshore.Wind.2005/documents/papers/Wind_resources_and_wake_effects/R.Barthelmie_Verificationofaneffiencymodel.pdf.

The freestream is the air far upstream from a wind turbine that is traveling at its natural velocity and that has not yet been slowed down, deflected, or otherwise impacted by a wind turbine or other obstruction.[15] Consequently, wind exiting a turbine contains less kinetic energy than does wind before passing through a turbine.[16] This diminished, turbulent wind from an upwind turbine reduces the energy entering downwind turbines, thereby decreasing the downwind turbines' overall energy output.[17]

C. Factors Determining the Wake

Two factors substantially impact the size, magnitude, and wake rose shape a wind turbine creates: (1) environmental and atmospheric conditions, and (2) the model of the wind turbine itself.[18] Both of these factors impact the wind speed, turbulence (wind speed variability), and atmospheric stratification (the layering of the atmosphere) above and around the turbine.[19]

1. Environment, Weather, Seasons, and Complex Terrain

Many different environmental factors, such as changes in the atmospheric boundary layer conditions, relative humidity, ambient

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15. Rebecca J. Barthelmie et al., *Modeling and Measuring Flow and Wind Turbine Wakes in Large Wind Farms Offshore*, 12 WIND ENERGY 431, 431–32 (2009) [hereinafter Barthelmie et al., *Modeling and Measuring*], *available at* http://onlinelibrary.wiley.com/doi/10.1002/we.348/abstract. A study of the Danish offshore wind farm Horns Rev indicated that wind speeds within the wind farm dropped to less than eighty percent of wind speed in the freestream. *See* Rebecca J. Barthelmie et al., Wake Model Evaluation in the UpWind and POW'WOW Projects 4 (Feb. 25–26, 2009) [hereinafter Barthelmie et al., Model Evaluation] (PowerPoint Presentation), *available at* http://www.ieawind.org/AnnexXXIIISecure/Meeting11/Rebecca%20Barthelmie%20-%20Wake%20model%20evaluation%20in%20the%20UPwind%20and%20POW%27WOW%20projects.pdf.

16. Barthelmie et al., *Modeling and Measuring*, *supra* note 15, at 431.

17. *See generally* Ashley B. Crabtree, *Wind Energy Faces Problem*, BISMARCK TIMES (June 10, 2005, 7:00 PM), http://bismarcktribune.com/news/opinion/mailbag/article_bd765b72-4ce6-5bd4-97b4-b08f0fe8a376.html.

18. Robert Conzemius, *Development and Testing of a Wind Simulator at an Operating Wind Farm*, Presentation Delivered at American Wind Energy Association, Windpower 2010 (May 26, 2010) (notes on file with DUKE ENVTL. L. & POL'Y F.); Rebecca J. Barthelmie, Wakes in Large Wind Farms (Mar. 2–3, 2011) [hereinafter Barthelmie, Wakes in Large Wind Farms] (PowerPoint Presentation), *available at* http://institute.lanl.gov/ei/_docs/Annual_Workshops/Wind_Workshop_2011/Barthelmie_LosAlamos.pdf.

19. Barthelmie, Wakes in Large Wind Farms, *supra* note 18; Rebecca J. Barthelmie, Power Losses Due to Turbine Wakes in Large, Irregularly Spaced Wind Farms, Presentation Delivered at American Wind Energy Association, Windpower 2010 (May 26, 2010) [hereinafter Barthelmie, Power Losses] (notes on file with DUKE ENVTL. L. & POL'Y F.).

temperature, wind velocity, complex terrain, and forestry, may impact the size and magnitude of wakes.[20] For instance, turbines, particularly larger ones that are 1.5 to 2.0 MW or greater in size and situated in a multi-row block pattern, cause changes in the air in the upper atmosphere, particularly when a group of turbines are in relatively close proximity to one another.[21] Humidity and turbulence may also impact wakes.[22] In addition, wind farms being developed today are often located in complex terrain or close to forests.[23] Both complex terrain and forestry impact wakes, due to how wind flows across, over, or through uneven surfaces, trees, buildings, and nearby land topography.[24]

2. Blade Characteristics

The blade length, pitch, and angle on which each blade is attached to a wind turbine all significantly impact wake formation as well. The wake behind "pitch-regulated" turbines whose blades can adjust their pitch to deliver a relatively constant amount of power output are influenced by the blade pitch angle and rotor speed, as well as by wind velocity, turbulence, and the amount of pressure the wind exerts on the blades themselves.[25] Notably, a number of commercial wind turbines have errors in the direction angle of their blades, thereby impacting the shape of the anticipated wake.[26] The number of turbine blades also impacts wake formation,[27] as the loss of momentum in air particles as they pass through the rotor disc

20. Barthelmie, Power Losses, *supra* note 19. According to Barthelmie, it is hard to determine precisely why large turbines cause these changes in the atmospheric boundary layer, as the current state of research in this area does not allow for such level of quantification. The speculation is that atmospheric properties above and downwind of large wind farms change, but by how much and whether these changes are of significance at all remain unanswered questions. Detectable impacts may only be discovered on a local scale. Moreover, wind speed and other atmospheric properties, such as stability, determine wake propagation. Wind speed profiles are also impacted by humidity, which in turn impacts stability, which then impacts wakes. At this time, the precise magnitude of all these effects still needs to be quantified. *Id.*; s*ee also* MANWELL ET AL., *supra* note 9, at 36; Barthelmie et al., Model Evaluation, *supra* note 15, at 10.

21. Barthelmie, Power Losses, *supra* note 19.

22. *Id.*

23. Barthelmie et al., *Modeling and Measuring*, *supra* note 15, at 432.

24. Christine Montavon et al., Advances in Wind Farm Flow Modeling Using CFD 30 (May 10–11, 2011) (PowerPoint Presentation) (on file with DUKE ENVTL. L. & POL'Y F.).

25. Thomas Hahm & Jurgen Kroning, *In the Wake of a Wind Turbine*, FLUENT NEWS, Spring 2002, at 5.

26. MANWELL ET AL., *supra* note 9, at 101, 120–21, 124; Barthelmie, Power Losses, *supra* note 19.

27. TONY BURTON ET AL., WIND ENERGY HANDBOOK 17 (2001).

depends on how close these particles are to the turbine blade itself.[28] Also, the shape of a blade's tip determines the amount of torque reduction at the tip ("tip loss").[29] Therefore, the number of blades, the blade shape, and the angles at which the blades are attached on a particular make, type, and size of a commercial wind turbine play a key role in determining the size, shape, and magnitude of the wake generated.

D. Turbulence and Wake Rotation

Wakes rotate in a corkscrew-like pattern.[30] Due to the exertion of torque on a turbine's rotor disc created by the wind passing through it, an equal and opposite torque is imposed on the air, called "reaction torque."[31] This reaction torque causes the air in wind-turbine-generated wakes to rotate in the opposite direction of that in which the turbine's blades rotate.[32] The pattern a particular wake forms is called a "wake rose."[33] Turbulence also impacts the shape and other characteristics of a wake rose,[34] which is why turbulence intensity is a major parameter in many wake models.[35] Turbulence refers to random fluctuations in wind speed for a designated area during a short time interval, such as during a period of approximately ten minutes.[36] Two main factors cause turbulence.[37] The first factor is wind flow disturbances that topographical features such as hills and mountains cause, effectively resulting in "friction" with the earth's

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28. *Id.* at 78–79.

29. *Id.*

30. Conzemius, *supra* note 18.

31. BURTON ET AL., *supra* note 27, at 47.

32. Conzemius, *supra* note 18. A "wind rose" may be defined as the direction and frequency with which the wind blows from a particular direction or from various directions at one specific location. *See* WINDUSTRY, COMMUNITY WIND TOOLBOX (WINDUSTRY TOOLBOX), CHAPTER 4: WIND RESOURCE ASSESSMENT 7 (2008), http://windustry.advantagelabs.com/sites/windustry.org/files/Wind%20Resource%20Assessment.pdf.

33. Conzemius, *supra* note 18.

34. BURTON ET AL., *supra* note 27, at 17.

35. Barthelmie et al., *Modeling and Measuring*, *supra* note 15, at 434.

36. MANWELL ET AL., *supra* note 9, at 30. Fluctuations can occur in the direction in which the wind is blowing (longitudinally), perpendicular to the direction in which the wind is blowing (laterally), and vertical with respect to the direction in which the wind is blowing (vertically). Although winds generally blow in the horizontal plane, forces are at play endeavoring to mix different temperature and pressure air masses over the earth's surface. *Id.* at 24. Pressure gradient, gravitational forces, air inertia, the earth's rotation, and frictions with the earth's surface collectively result in turbulence, affecting the winds in the atmosphere. *Id.*

37. BURTON ET AL., *supra* note 27, at 17.

surface.[38] Two currents of air that move at different directions or at different speeds can also cause friction.[39] The friction occurring at the boundary layer[40] of these two currents is wind shear.[41] Wind shear makes the wake less rounded and more oval in shape. The second main factor that causes turbulence is temperature variation, which causes air masses to move vertically, thereby impacting air density in a particular location.[42] The combination of the friction factor with the thermal variation factor, together with other atmospheric conditions such as pressure and humidity, results in turbulence.[43] When low levels of atmospheric turbulence are present, wind turbine wakes that can materially impact the energy generation of downwind turbines can persist over relatively large distances.[44]

Blade characteristics also impact the amount of turbulence a particular wind turbine generates. Atmospheric turbulence reacts with turbulence generated from other turbines in a wind farm, thereby compounding the turbulence an upwind turbine generates and a downwind turbine experiences.[45]

E. Cumulative Effect

When multiple turbines are located in a wind farm, the direction the wind blows changes regularly, causing certain turbines to be in the wake of other turbines.[46] Turbines in large wind farms experience the cumulative effect of multiple wakes.[47] Cumulative wakes decrease wind speed as wind travels downstream.[48] Downstream turbines are impacted in succession, as the wind speed is successively and

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38. *Id.*

39. THOMAS E. KISSELL, INTRODUCTION TO WIND PRINCIPLES 1, 34 (2011). Wind friction is the friction between two currents of air, which are moving either at different directions or at different speeds. This friction between two air currents is an indication of wind shear. *Id.*

40. *Id.* at 34. Wind in the "boundary layer" is wind in the air layer that is nearest to the earth's surface. *Id.* Wind in the boundary layer is impacted by diurnal changes in heat, temperature, and moisture near the earth's surface, and generally responds to these impacts in an hour or less. *Id.*; *see also infra* note 112.

41. *Id.* at 34, 273.

42. BURTON ET AL., *supra* note 27, at 17.

43. *Id.*

44. *Id.*

45. Conzemius*, supra* note 18.

46. KISSELL, *supra* note 39, at 38.

47. Montavon et al., *supra* note 24, at 3; MANWELL ET AL., *supra* note 9, at 426.

48. MANWELL ET AL., *supra* note 9, at 426; Conzemius, *supra* note 18.

cumulatively reduced at each turbine.[49] How significantly a wind wake will impact a particular "end" turbine is a function of the number of turbines upwind from such turbine, as well as complex wake interactions, such as the number of whole or partial wakes from neighboring rows that merge laterally and downwind with other wakes that flow downstream to such turbine.[50]

F. Distance Between Wind Turbines

Individual wind turbines may be adversely impacted by the turbulent wakes from other upwind turbines, with the magnitude of the impact depending largely on the turbines' respective rotor sizes and distance between one another, as well as on the overall shape of the wind farm and turbine spacing therein.[51] Decay in a wake is a function of the distance behind the turbine generating that wake.[52] The further away a downwind turbine is located from an upwind turbine, the less impact it experiences in terms of wake loss and wind velocity deficit from the upwind turbine.[53] While the distance the wake effect extends is still a matter of debate, experts agree that downwind wake effect from an individual commercial wind turbine can persist for a minimum distance of eight to ten times the turbine's rotor diameter (equaling up to more than half a mile)[54] and can persist even longer where turbulence is low, such as in offshore locations.[55]

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49. Conzemius, *supra* note 18; s*ee, e.g.*, Naomi Pierce, *Wake Up and Smell the Wake Effects*, 4 N. AM. CLEAN ENERGY 31, 31 (2010) (documenting lost energy output in downstream wind farms from five to fifteen percent).

50. BURTON ET AL., *supra* note 27, at 235; Barthelmie et al., *Modeling and Measuring*, *supra* note 15, at 432; *see, e.g.*, Pierce, *supra* note 49, at 31. As data taken from the Danish offshore wind farm Horns Rev indicate, when multiple wakes in neighboring rows merge, they can only expand vertically upward. This phenomena is similar to (but is not identical to) what occurs on land after a change in terrain roughness. BARTHELMIE ET AL., TURBINE CLUSTERS, *supra* note 14, at 1.1.

51. MANWELL ET AL., *supra* note 9, at 422–23; Barthelmie, Wakes in Large Wind Farms, *supra* note 18; Barthelmie, Power Losses, *supra* note 19.

52. Barthelmie, Wakes in Large Wind Farms, *supra* note 18; Barthelmie, Power Losses, *supra* note 19.

53. MANWELL ET AL., *supra* note 9, at 425. For this reason, turbines should be spaced as far a distance from one another as possible within the boundaries of a given wind farm project. Pierce, *supra* note 49, at 31.

54. MANWELL ET AL., *supra* note 9, at 423; Barthelmie, Power Losses, *supra* note 19; Montavon et al., *supra* note 24, at 33.

55. Barthelmie et al., Model Evaluation, *supra* note 15, at 14; Barthelmie, Wakes in Large Wind Farms, *supra* note 18; Barthelmie, Power Losses, *supra* note 19.

Some experts even estimate that wake effect continues even longer, possibly extending several kilometers.[56]

Such findings render conventional zoning setback requirements relatively ineffective in minimizing an upwind turbine's impact on a downwind turbine's productivity. For instance, jurisdictions such as Minnesota have a setback of five times the turbine's rotor diameter from an adjacent property line.[57] If wake effect persists for a minimum distance of eight rotor diameters, then this lack of a sufficient buffer zone between an upwind turbine and a downwind turbine located just over an adjacent property line could substantially impact the amount of power loss the downwind turbine experiences.

G. Efficiency, Productivity, and Underperformance

The distance between upwind turbines and downwind turbines is also important from an energy production perspective. "Turbulence impacts" makes turbines in a wake's path less efficient at harvesting energy.[58] Wind power efficiency is dependent on several factors, including the positioning of turbines near one another or near other structures.[59] If wind turbine spacing is changed by one rotor diameter, the efficiency and power output of that downwind turbine changes by approximately one percent.[60] Because the productivity of a wind turbine is highly wind speed dependent,[61] downwind turbines that experience wakes produce less power than upwind turbines, particularly compared to upwind turbines that receive wind in the freestream.[62] Thus, a legally mandated setback distance that is too short, or the absence of a legally mandated setback distance, can result in an insufficient buffer zone between an upwind and a downwind turbine. This insufficient buffer zone can substantially decrease the downwind turbine's overall power output.

Insufficient distance between turbines, together with wakes created from upwind turbines, also may negatively impact downwind turbines by causing the downwind turbines to experience increased

56. Montavon et al., *supra* note 24, at 33.

57. Troy Rule, *A Downwind View of the Cathedral: Using Rule Four to Allocate Wind Rights,* 46 SAN DIEGO L. REV. 207, 208–09 (2009); Crabtree, *supra* note 17.

58. *See* KISSELL, *supra* note 39, at 274.

59. Hahm & Kroning, *supra* note 25, at 5.

60. Barthelmie et al., Model Evaluation, *supra* note 15, at 16, 17; Barthelmie, Power Losses, *supra* note 19.

61. Barthelmie, Power Losses, *supra* note 19.

62. Barthelmie et al., *Modeling and Measuring*, *supra* note 15, at 431.

mechanical loads and diminished operational capacity.[63] The diminished capacity is a result of vibration-induced fatigue on these downwind turbines' rotors, which may potentially adversely impact the power lines to which such turbines are connected.[64] As one study illustrates, the velocity of the wind flowing to a downwind turbine located four rotor diameters behind an upwind turbine was non-uniform, causing the downwind turbine to experience diminished wind speed and resulting in reduced energy generation.[65] This downwind turbine also experienced higher mechanical loads associated with the more turbulent air flow accompanying the wind wakes.[66] If there are considerable shifts in wind speeds due to wake effect, then the owner of the downwind turbine experiencing these wake-effect-induced loads should consider installing vibration dampers[67] on the power lines connected to such turbines.[68]

H. Predicting and Measuring Wakes to Mitigate Against Underperformance

Landowners need to be able to predict wake effect and wake loss in order to optimize the wind flowing across their land, determine the layout of wind turbines on their land, minimize wake-induced power losses, and maximize the productivity of each turbine on their land.[69] Wake effect and wake loss contribute to turbine underperformance, accounting for a substantial portion of the gap between predicted and actual wind turbine performance.[70] Predicting power loss from wind

63. Steffen WuBow et al., *3D-Simulation of the Turbulent Wake Behind a Wind Turbine*, J. PHYSICS: CONF. SERIES, vol. 75, Aug. 2007, at 1; Hahm & Kroning, *supra* note 25, at 5.

64. Hahm & Kroning, *supra* note 25, at 5.

65. *Id.* at 6.

66. *Id.*

67. A vibration damper is a device that acts like a shock absorber and that may be placed on various parts of a wind turbine, such as in the gearbox, to reduce mechanical vibrations and structural fatigue on the turbine itself. *Low-Noise and Low-Vibration Wind Energy*, LANXESS, http://lanxess.com/products-applications/damping/wind-energy/ (last visited Dec. 21, 2011).

68. Hahm & Kroning, *supra* note 25, at 7. Further distances apart between turbines, though, may mean there are additional costs associated with laying more electric cable and other construction costs. *See* WINDUSTRY TOOLBOX, CHAPTER 5: SITING GUIDELINES 8 (2008), http://windustry.advantagelabs.com/sites/windustry.org/files/Siting.pdf.

69. Barthelmie et al., Model Evaluation, *supra* note 15, at 20; Barthelmie, Power Losses, *supra* note 19.

70. Barthelmie, Power Losses, *supra* note 19.

wakes is a measure downwind turbine owners should take to better assist them in anticipating the turbines' actual productivity.[71]

While there are no standardized industry guidelines or processes for measuring wake loss at this time,[72] wake modeling can significantly improve the prediction of wind speed patterns across particular tracts of land and turbine sites.[73] Currently, the energy loss associated with wake loss is modeled using computer software packages that account for blade pitch, wind speed, wind direction, turbulence intensity, turbulence length, and rotor speed.[74] Wake modeling software, however, is still in a relatively early stage of development. The software continues to evolve; however, software is only as good as the scientific data supporting it. For wake modeling software to be more robust, additional scientific research on the wake effect phenomenon needs to be conducted. Because wake loss from commercial wind turbines is a phenomenon that has only recently begun to capture broader attention among scientists and others in the wind industry, few studies on wake effect have been conducted to date. Additional research needs to be conducted to more fully understand the scientific factors that contribute to wake loss before any industry benchmarks are set.[75]

A number of technologies can be used today to measure the atmospheric conditions that can affect wind turbine wakes.[76] The current industry standard is to utilize cup anemometers that are mounted on meteorological masts to measure wind speeds and other items.[77] Other ground-based, remote sensing measurement techniques such as Sonic Detection and Ranging (SODAR) systems and Doppler Light Detection and Ranging (Doppler LIDAR) systems are also gaining popularity.[78] SODAR measures wind speed by measuring the

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71. Barthelmie et al., *Modeling and Measuring*, *supra* note 15, at 431.

72. Barthelmie, Wakes in Large Wind Farms, *supra* note 18; Barthelmie, Power Losses, *supra* note 19.

73. Montavon et al., *supra* note 24, at 33.

74. Hahm & Kroning, *supra* note 25, at 6.

75. Barthelmie, Wakes in Large Wind Farms, *supra* note 18; Barthelmie, Power Losses, *supra* note 19.

76. MANWELL ET AL., *supra* note 9, at 71.

77. *Id.* at 68.

78. *See* EUROPEAN WIND ENERGY ASS'N, WIND ENERGY - THE FACTS, AN ANALYSIS OF WIND ENERGY IN THE EU 39–40 (2009), *available at* http://www.wind-energy-the-facts.org/documents/download/Chapter1.pdf.

scattering of sound waves by atmospheric turbulence.[79] Doppler LIDAR measures wind speed by using laser remote sensing to measure the frequency shift in emitted light that occurs when the light hits a moving airborne particle (typically dust, water particles, pollution, or pollen moving at the same velocity as the wind).[80] This frequency shift—caused by all moving objects—is known as the Doppler Effect.[81] The size of the shift corresponds to the speed of the moving object, so LIDAR systems convert the frequency shift into a velocity to output wind speed.[82] Both SODAR and LIDAR may be used for purposes of measuring wind speeds at or above turbine hub heights.[83] These systems are attractive because they can remotely obtain hub-height wind speed measurements from portable, ground-based instruments.[84] However, these advanced measurement techniques are generally viewed as supplementary to in-situ cup anemometry measurement equipment because wind turbine power output is defined with wind speed measurements from cup anemometers.[85]

In addition, the industry utilizes computer programs that employ the Ainslie Eddy Viscosity wake model to predict the effect that upwind wakes will have on downwind turbine energy output.[86] These software packages use formulae to calculate atmospheric turbulence, similar to those used in the field of computational fluid mechanics

79. STUART BRADLEY ET AL., SODAR CALIBRATION FOR WIND ENERGY APPLICATIONS 1–7 (2005); Conzemius, *supra* note 18.

80. DANIEL W. JAYNES ET AL., RENEWABLE ENERGY RES. LAB., MASS. TECHNOLOGY COLLABORATIVE FINAL PROGRESS REPORT: LIDAR INTRODUCTION 2, 9–10 (2007), *available at* http://www.ceere.org/rerl/publications/reports/LIDAR_Final_Report_June_2007.pdf; MICHAEL HARRIS ET AL., NAT'L RENEWABLE ENERGY LAB., TECHNICAL REPORT NREL/TP-500-39154, LIDAR FOR TURBINE CONTROL 2–3 (2006), *available at* http://www.nrel.gov/docs/fy06osti/39154.pdf; AXEL ALBERS, DEUTSCHE WINDGUARD CONSULTING GMBH, EVALUATION OF ZEPHIR 1 (2006), *available at* http://www.windguard.de/fileadmin/media/pdfs/UEber_Uns/DEWK_2006/paper_WindGuard_LIDAR_DEWEK06.pdf.

81. *See* JAYNES ET AL., *supra* note 80, at 4.4; HARRIS ET AL., *supra* note 80, at 2–4 (explaining the Doppler Effect and the frequency-to-velocity conversion algorithm).

82. HARRIS ET AL., *supra* note 80, at 2–4; DANIEL W. JAYNES ET AL., U. MASS. AMHERST WIND ENERGY CENTER, VALIDATION OF DOPPLER LIDAR FOR WIND RESOURCE ASSESSMENT APPLICATIONS 2 (2007), *available at* http://www.umass.edu/windenergy/publications/published/2007/AWEA07_LIDAR_Validation.pdf.

83. Barthelmie et al., *Modeling and Measuring*, *supra* note 15, at 432.

84. *Id.*

85. MANWELL ET AL., *supra* note 9, at 71.

86. *See* BURTON ET AL., *supra* note 27, at 35.

(CFM).[87] CFM is a fast-growing area of fluid mechanics in which engineers combine knowledge of fluid flow physics with their skills in numerical analysis and computer programming so that they may use computers to solve differential equations used for purposes of calculating fluid motion.[88] These software packages may be used to optimize wind farm layouts and individual turbine positioning to maximize each turbine's efficiency and reduce wake loss impact on various turbines in a given turbine array.

Most landowners do not have access to these expensive technologies or software programs to predict wind speeds or model wake loss. Lack of access to these tools and technical data can make it difficult for landowners to accurately predict wake effect. Because wake effect reduces turbine productivity, landowners often experience reduced profits for turbines situated on their property. In these instances, to minimize their potential financial losses, landowners must rely on information provided by developers. This reliance can disadvantage landowners, as developers may have financial or other interests that may be different from landowners' interests with respect to wind turbine siting. Therefore, landowners who have entered into productivity-based leases with developers should be skeptical of the data developers provide to them, and should ensure that the developers are disclosing all relevant information that may impact the landowners' wind turbine siting decisions.

II. IMPLICATIONS OF WAKE EFFECT FOR ADJACENT UPWIND AND DOWNWIND LANDOWNERS: ECONOMIC FEASIBILITY OF AN IMPACTED PROJECT VERSUS THE FIRST-IN-TIME DEVELOPER

With increased density of wind developments comes increased potential for conflicts arising from issues relating to wake effect, wake loss, and compatible land uses. Current case law is silent on both the issue of rights bestowed to those sites having potentially suitable wind resources, as well as the issue of developers' ability to seek recourse

87. *Id.*

88. PHILIP M. GERHART ET AL., FUNDAMENTALS OF FLUID MECHANICS 30 (2d ed. 1992). In contrast to CFM, computational fluid dynamics (CFD) is a branch of fluid mechanics that replaces the governing partial differential equations involved in calculating fluid flow with numbers, using computers to solve algorithms and mathematic formulas for purposes of analyzing how fluid flows over a given parcel or other area of interest. *Id.* at 37; JOHN D. ANDERSON, JR. ET AL., COMPUTATIONAL FLUID DYNAMICS: AN INTRODUCTION 6 (3d ed. 2009).

for diminished wind capacity against adjacent developers whose projects cause such diminution.

In practical terms, wake effect impacts both the developer who contemplates erecting turbines on the upwind property, as well as the developer who contemplates erecting turbines on the adjacent downwind property. For instance, presume either (1) a situation in which both the upwind developer and the downwind developer possess permits and neither developer has begun construction, or (2) a situation in which the upwind developer is the second-in-time developer. The upwind developer's wind turbines' wake effect could cause diminished, turbulent winds to flow to the downwind developer's turbines.[89] The downwind developer's project, as a result, could be adversely impacted because the originally projected wind levels and the economic assumptions (including carefully calculated electricity production and profitability estimates) of the contemplated project would be rendered inaccurate.[90] If the downwind turbines are already constructed, the downwind developer could sue the upwind developer using a nuisance theory for damages due to lost productivity caused by the upwind turbine's wake. The downwind developer also could sue the upwind developer using a negative rights theory, supporting the downwind developer's right not to have its turbines adversely impacted by the upwind developer's actions. Currently, the law is unclear which party would prevail in such a dispute.[91] Moreover, in such a scenario, an upwind developer faces a Hobson's choice of whether to (1) build the wind project and potentially be confronted with unpleasant litigation from neighboring landowners, or (2) forgo project construction altogether. Given such a choice, the upwind developer may reason that the potential cost of litigation outweighs the potential profits from turbine installation, and may sacrifice project construction.[92]

Alternatively, if an upwind developer already has constructed turbines on property adjacent to the property on which a downwind developer is contemplating erecting wind turbine(s), then the downwind developer is faced with an equally unpleasant Hobson's choice. It may choose to (1) build its project and either (a) forgo

89. Rule, *supra* note 57, at 209.

90. *Id.*; K.K. DuVivier, *Animal, Vegetable, Mineral – Wind? The Severed Wind Power Rights Conundrum*, 49 WASHBURN L.J. 69, 96 (2009).

91. Rule, *supra* note 57, at 210.

92. *Id.*

maximization of its turbines' production capabilities or (b) erect fewer turbines than originally envisioned due to turbine siting and setback consideration, or (2) forego construction of the wind project altogether. Without appropriate legal standards in place, the downwind developer may reason that the costs associated with the project are not worth the potential long-term returns, and, consequently, may abandon the project.[93]

Ultimately, if either developer in the above cases elects to forego turbine installation, then its choice adversely impacts society, as this choice is a step toward failing to achieve social goals that most states value. In the United States, thirty-one states have a renewable portfolio standard (RPS) or alternative energy portfolio standard.[94] In some states, these standards are mandatory and in others the standards are an aspirational target.[95] In either case, aspiring to achieve an RPS target demonstrates the value a state legislature places on renewable energy production and delivery within its boundaries. Choosing to abandon a wind project, consequently, thwarts the purpose behind having a state RPS because abandonment results in a lost opportunity to harvest wind energy and to assist in meeting a state's RPS.

A scenario similar to one described above has already occurred. In 2008, both Peak Wind and Florida Power and Light (FPL)[96] announced plans to construct wind farms on a glacial ridge northeast of Valley City, North Dakota.[97] Peak Wind, the downwind developer in this scenario, voiced concern about the potential wake effect FPL's turbines would have on its neighboring, downwind turbines. Peak Wind was particularly concerned because at the time, North Dakota did not have setback guidelines mandating minimum requirements for how far away a turbine should be located from an adjacent

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93. *Id.*

94. *See* CTR. FOR CLIMATE & ENERGY SOLUTIONS, *supra* note 6, at 1–9 (listing the states with RPSs).

95. *Id.* at 1.

96. NextEra Energy, Inc., previously known as FPL Group, is the parent company of the subsidiary Florida Power and Light. NextEra Energy, Inc. also owns NextEra Energy Resources, which produces more wind energy than any other company in the United States. Susan Salisbury, *FPL Not About to Blow Chance to Harness Wind Power*, PALM BEACH POST (Oct. 27, 2010, 11:34 AM), http://www.palmbeachpost.com/money/fpl-not-about-to-blow-chance-to-harness-993672.html; *see also Fact Sheet,* NEXTERA ENERGY, http://www.nexteraenergy.com/company/factsheet.shtml (last visited Oct. 5, 2011).

97. Lauren Donovan, *Two Energy Projects Competing for the Wind*, BISMARCK TRIBUNE, Feb. 22, 2008, *available at* http://bismarcktribune.com/news/local/article_4bd1f0d6-6616-512b-970f-b4301800f774.html?print=1.

neighbor's property line.[98] In the absence of setback guidelines, Peak Wind requested that the county zoning commissioners apply the same setback standard used by the Minnesota Public Utilities—a standard that requires wind turbines to be spaced three to five rotor diameters away from an adjacent property line. Peak Wind argued that FPL previously used similar spacing standards in the past and should be required to use the same standard with respect to turbine spacing relative to the adjacent neighbor's property line.[99]

Peak Wind, as the downwind developer, would be detrimentally impacted by the wind wakes created from FPL's upwind turbines if FPL's turbines were not required to follow Peak Wind's proposed property line setback limit. Siting FPL's turbines closer to the property line than Peak Wind's proposed setback limit would likely force Peak Wind to either (1) construct fewer turbines than planned so its turbines could be sited further away from the property line than desired, thereby ensuring its turbines would experience minimal wake effect from FPL's upwind turbines; or (2) construct its planned number of turbines, including those close to the property line, but subjecting these turbines to greater wake effect impacts from FPL's upwind turbines—likely leading to less energy production. Under either scenario, the amount of energy that the Peak Wind turbines would produce and the related profits generated from such production would be diminished. From FPL's perspective, applying the property line setback parameters that Peak Wind sought could render FPL's project financially unfeasible because fewer turbines could be placed on the parcel, resulting in reduced energy production and profits. Moreover, if the property line setback parameters Peak Wind desired were imposed, then certain landowners closest to the property line who would have had FPL's turbines on their respective tracts of land but for the setback requirement would not be able to have these turbines placed on their property and would not have access to payment rights or income streams associated with having one or more turbines on their property. As a result, these landowners could generate dissention and potentially be instrumental in eroding or even eliminating essential community support and buy-in for FPL's project.[100]

98. *Id.*
99. *Id.*
100. *Id.*

To resolve this matter, the zoning commissioners looked at established precedent, as North Dakota previously had approved FPL's request on other FPL projects to space one or more of its turbines just far enough away from the adjacent neighbor's property line so that if one turbine fell, it would not extend across that neighbor's property line.[101] Based on this precedent, the zoning commissioners determined to apply the same "one fallen turbine" requirement for FPL in the instant case. This outcome is much more favorable to FPL than to Peak Wind because a commercial wind turbine's size is significantly smaller than three to five times its rotor diameter. As a result, Peak Wind's wind rights as the downwind developer effectively did not receive protection in this matter.

One zoning commissioner who was involved in handling the FPL–Peak Wind zoning decision explained that the resolution reached needed to be as fair as possible for all parties involved while not pitting one developer against the other and protecting the wind rights of all landowners.[102] Nevertheless, the outcome of this matter illustrates that while imposing a certain property line setback limit has the potential to render a project financially unfeasible and generate public dissention for an upwind developer, failure to apply a setback limit may have undesirable consequences for the downwind developer.

III. STRIKING THE BALANCE – MAXIMIZATION OF PRODUCTIVITY IN THE FAIRNESS BALANCE

Wind policy standards should consist of two components. The first component should draw upon the utilitarian-based concept of maximizing production of the greatest amount of wind-generated energy for the greatest number of people. It should also encourage and promote wind power as a renewable energy that is viewed as developmentally positive for the public's well-being. Such an approach would maximize the public's ability to benefit from the use of clean, non-greenhouse-gas-generating alternative energy. The second component should balance the rights of the most directly impacted parties, according to principles of fairness. This second prong would allow individual landowners to maximize their future profits based on a definitive, fair quantity of wind energy to which such landowners should be entitled. Notably, in such instance, a

101. *Id.*
102. *Id.*

developer whose turbines are adversely impacted as a result of wake effect potentially may not realize the maximum production levels from its turbines, and as a result, not reap the corresponding monetary benefit associated with optimal production levels. The developer's turbines, nevertheless, may still produce enough energy to make its project installation profitable and produce an acceptable level of return on investment.

To develop ideal wind policy standards that combine these two key components—maximizing production of wind energy for the greatest number of people and balancing the rights of most directly impacted parties according to fairness principles—this part examines American legal theories from legal scholars, analogizes wind to sunlight, and analyzes legal concepts from Japan and Great Britain with respect to sunlight regulation and access.

A. American Legal Theories from Legal Scholars

1. The Rule Four Damages-Liability Rule

In their widely-cited article *Property Rules, Liability Rules and Inalienability: One View of the Cathedral*, Judge Guido Calabresi of the U.S. Court of Appeals for the Second Circuit, and A. Douglas Melamed, a noted legal scholar, devise a conceptual framework to address the areas of property law and tort law together from a unified perspective, based on traditional law and economics theories.[103] Within this framework is a method used to resolve disputes based on a damages–liability rule derived from concepts of economic efficiency known as "Rule Four."[104] For example, under Rule Four, a court could hold that a first-in-time polluter has the right to continue polluting unless an adjacent resident elects to pay the polluter monetary damages in order to enjoin further pollution.[105] The Arizona Supreme Court decision in *Spur Industries v. Del E. Webb Development Co*.[106] illustrates the practical application of Rule Four.

103. Guido Calabresi & A. Douglas Melamed, *Property Rules, Liability Rules, and Inalienability: One View of the Cathedral*, 85 HARV. L. REV. 1089 (1972). The article's title refers to artist Claude Monet's series of paintings of Rouen Cathedral, whereby the authors suggest that the same subject should be considered from different perspectives and points of view. *Id.* at 1089 n.2.

104. *See id.* at 1116; James E. Krier & Stewart J. Schwab, *Property Rules and Liability Rules: The Cathedral in Another Light*, 70 N.Y.U. L. REV. 440, 442–44 (1995).

105. Calabresi & Melamed, *supra* note 103, at 1116.

106. 494 P.2d 700 (1972).

In *Spur Industries*, Del Webb, a retirement community, purchased property and located next to an adjacent, first-in-time landowner, Spur Industries, a feedlot owner.[107] Advocating a balancing of factors approach by weighing economic efficiency, distributional, and other judicial concerns, the court ruled that while Spur Industries' activities created a nuisance that could have been foreseeable by Del Webb but not Spur Industries, the best economic decision (in terms of considering how easy it would be for each of the individuals at Del Webb versus those at Spur Industries to relocate versus stay) would be to require Spur Industries to move, and to have Del Webb indemnify Spur Industries for the damages it sustained.[108]

While a balancing of factors approach is generally positive as a matter of policy, and may be helpful in resolving legal disputes, Rule Four's balancing approach in the context of wake effect and wind rights is not ideal, as it encourages an adversarial, litigation-based approach between parties to resolve their differences. Litigation should not be the preferred approach for resolving wind rights issues relating to wake effect. As a matter of policy, the better approach would be to negotiate an amicable resolution between the parties before resorting to litigation. Rule Four presumes that a landowner will be damaged by his adjacent neighbor's actions, and that the offending adjacent landowner will be liable for monetary or other damages to compensate the damaged neighbor. Ideally, the rules governing wake loss should not begin with an underlying "fault and damages" approach, which necessarily is adversarial and pits one developer against an adjacent developer.

2. Rule Five and the Best Chooser Principle

Using Calabresi and Melamed's Rule Four as a point of departure, James Krier and Stewart Schwab advocate the "best chooser" principle as "Rule Five."[109] Under the Rule Five construct, a judge would view the debate between parties from an economic perspective, and would enter an order after requiring the party who is in the best position to make the most economically efficient transaction-cost-based choice (the "best chooser") determine the ultimate outcome of the situation by electing to either (1) continue causing damage to the other party without receiving compensation, or

107. *Id.* at 701–04.
108. *Id.* at 705–08.
109. *See* Krier & Schwab, *supra* note 104, at 470–71.

(2) stop causing the damage and receive compensation from the other party.[110] If the best chooser selects option one, the best chooser continues to cause harm to the other party and receives no payment from the damaged party. If the best chooser selects option two, the best chooser ceases its harm-causing actions, and the other party pays damages to the best chooser, as calculated by the judge.[111]

The "best chooser" theory is also not optimal for resolving wake effect disputes between adjacent landowners. Like Rule Four, the theory behind Rule Five presumes that the best manner in which to resolve disputes is to automatically default to litigation as the first choice for dispute resolution. As discussed above, litigation is an inherently adversarial process. The better approach is to have a less confrontational, more amicable dispute resolution process where both parties can benefit and have a marginal "win," as opposed to one party having an absolute loss.

B. Analogizing Wind to Sunlight

The Rule Four and Rule Five theories are applicable to wind turbines insofar as these theories can be applied to the upwind turbine developer as the party causing the damage to the downwind developer. Analyzing the characteristics of wind and making an appropriate analogy to the most similar natural resource for which case law and regulations already exist is the appropriate and most logical method to assess damages, apply damages theories (such as Rule Four and Rule Five), and devise the most fair legal construct for resolving how to address damages that the downwind developer sustains.

Historically, wind has been analogized to water and to oil. This analogy is not ideal for several reasons. First, from a scientific perspective, wind is not a liquid or solid and therefore does not flow in the same manner as a liquid or solid would flow. Laws governing wind should take into account wind's physical properties, and be tailored accordingly. Second, from a legal perspective, the laws covering wind rights generally evolved out of the western United States, where water rights and oil rights play a major role. Many large wind farms are located in the West and in the Midwest. Analogizing wind to water or oil would make it more convenient and much easier

110. *Id.* at 472–73.
111. *Id.*

to craft laws for wind rights based on laws governing water rights and oil rights because these other laws already exist. However, in the case of wind rights, the legal analogy to laws for substances or other items has to be one of appropriateness, rather than one of convenience with respect to existing laws.

The better approach is to analogize wind to sunlight. Wind is a form of solar energy and shares certain characteristics with sunlight.[112] Wind also can be analogized to sunlight insofar as both sunlight and wind require the use of power collection–conversion devices. To function optimally (or at all, in the case of solar collection devices), both devices must have unobstructed access to sunlight or to wind, respectively. If a solar collection device is obstructed or has a shadow cast on it, the device may be rendered useless. Similarly, a utility-scale wind turbine must have access to unobstructed wind in the freestream to produce energy at maximum capacity. If the wind flowing to a turbine is "obstructed" by wake effect from an upwind turbine, the downwind turbine will likely be rendered less productive, with the level of diminished productivity depending on the amount of wake effect the adjacent upwind turbine creates and the distance the upwind turbine is located from the downwind turbine. Also, both sun and wind have temporal elements, as greater amounts of sunlight and wind flow to a particular area at specific times during any given day. For instance, more direct sunlight may reach a solar collector in mid-afternoon when the sun is at its peak, compared to late afternoon and twilight when the sun is starting to set. Likewise, wind may blow stronger at different times throughout the day and night, due to the earth's heating and cooling patterns.[113]

112. Wind is a form of solar energy, insofar as when the sun heats the earth, differential heating of the earth's surface occurs. When air gets warmer, it rises and circulates in the atmosphere, while cooler air rushes in to take the place of the warmer air. The act of the cool air replacing the warmer air is what creates wind. *See* BURTON ET AL., *supra* note 27, at 12. *See generally How Wind Turbines Work*, U.S. DEP'T OF ENERGY, ENERGY EFFICIENCY AND RENEWABLE ENERGY, http://www1.eere.energy.gov/wind/wind_animation.html (last visited Jan. 6, 2012).

113. KISSELL, *supra* note 39, at 36. In certain locations, as the earth cools, winds die down at night. MANWELL ET AL., *supra* note 9, at 29. Diurnal variations in wind speeds, or, rather, differences in wind speeds at different times over a twenty-four hour period, such as between day and night, occur due to differential hearing of the earth's surface. During a typical diurnal variation, winds increase during the day and are lowest from midnight to sunrise. The smallest diurnal variations in wind speeds occur during winter, while the largest occur during summer and spring. *Id.*

C. Enlightening Theories – Legal Concepts from Overseas Governing Sunlight Regulation

As the United States is currently devoid of a vast body of case law discussing sunlight rights, lessons may be learned from reviewing other countries' treatment of sunlight access, rights, and regulation. Both Japan and Great Britain have implemented legal precedents governing solar access rights. Analyzing the rationale behind these precedents is useful for purposes of discovering the origin and theories behind these other countries' approach to solar rights allocation. The lessons that we can learn from the theories and rationale behind these other countries' legal precedents are instructive for providing us with a point of departure for shaping our own domestic legal precedents governing wind rights.[114]

1. Theories Behind Japan's Solar Access Laws

Japan has both common law and statutory law precedent governing solar access rights. Under Japanese common law, the leading case that has set precedent for sunlight protection is *Mitamura v. Suzuki*.[115] In *Mitamura*, an adjacent owner erected a second floor addition to his property, blocking sunlight to plaintiff's property.[116] Because of the loss of sunlight, the plaintiff's family's health was detrimentally impacted over time, forcing the plaintiff and his family to move.[117] The Tokyo High Court, ruling in favor of the plaintiff, held that access to light was a fundamental right, due to sunlight's being "worthy of protection under the law as fundamental and necessary for life, *profit*, and the enjoyment of a pleasant and healthy life."[118] The Tokyo High Court's decision was based on the Japanese doctrine of *Kenri no ranyo*, or "abuse of right," a doctrine

114. For a detailed discussion of Great Britain's and Japan's respective laws, see Dwight C. Seeley, *Comparative Aspects of Access to Sunlight: The United States, Great Britain, and Japan*, 21 Harv. Int'l L.J. 687 (1980).

115. *See* Seeley, *supra* note 114, at 711 (citing Mitamura v. Suzuki, 187 Hanrei Times 118 (Tokyo Dist. Ct., Dec. 24, 1965), *rev'd* 211 Hanrei Times 218 (Tokyo High Ct., Oct. 26, 1967), *aff'd* 26-5 Sai-han Minshu 1067 (Sup. Ct., June 27, 1972); *see also* Steven S. Miller, *Let the Sunshine In: A Comparison of Japanese and American Solar Rights*, 1 HARV. ENVTL. L. REV. 578, 582 (1976).

116. Seeley, *supra* note 114, at 711.

117. *Id.*

118. *Id.* at 712 (citing Mitamura v. Suzuki, 211 Hanrei Times 218, 219 (Tokyo High Ct., Oct. 26, 1967)) (emphasis added). The Tokyo High Court recognizes sunlight as a property-like object to which is attached a bundle of rights. Notably, one of these rights is the right of the person who has the right to sunlight to have the fundamental right to profit from that sunlight.

that balances one landowner's rights against the duty of the adjacent landowner to bear inconveniences that may arise from the exercise of the adjacent landowner's rights.[119] Once a maximum level of inconvenience synonymous with the "limit of human endurance" is reached, the adjacent landowner becomes liable to the impacted neighbor for damages if the threshold is exceeded.[120] Unfortunately, however, a bright line rule defining when one crosses this threshold limit does not exist. Consequently, it is open to interpretation as to when this limit is reached and exceeded. This gray area is particularly troublesome when gauging the extent of the adverse impact of the immediately adjacent neighbor's actions before legal repercussions may be pursued.

Similar to Calabresi and Melamed's basis for their Rule Four analysis (using the example of Claude Monet's series of paintings of Rouen Cathedral to suggest that the same subject should be considered from different perspectives),[121] the *Mitamura* ruling should also be viewed from another perspective, one that takes into account the social context in which the two parties are situated. Adding this feature causes the debate between adjacent owners to be viewed from another angle, shifting the analysis from merely that of what constitutes a stand-alone abuse of right in the abstract, to what constitutes an abuse of right (or, rather, an unreasonable exercise of such right) within the context of the particular social order in which the parties are located.[122] This latter approach is one that the Japanese Civil Code employs. Under this Code, judges consider individuals' rights against one another and within the current prevailing social order.[123] As applied to the *Mitamura* case, Suzuki's actions were held to be both disproportionately damaging to his neighbors' health, and antisocial, given the social context.[124]

Comparing the *Mitamura*–Japanese Civil Code approach, the damages-liability approach of Rule Four and the "best chooser" approach of Rule Five, it becomes evident that all three approaches are intended to promote the general welfare and well-being of the existing community, albeit through different means. Relative to the Rule Four and Rule Five approaches, the *Mitamura*–Japanese Civil

119. *Id.*
120. *Id.*
121. Calabresi & Melamed, *supra* note 103, at 1089 n.2.
122. Seeley, *supra* note 114, at 713.
123. *Id.*
124. *Id.*

Code approach is more focused on preserving the existing community by promoting amicable relations among neighbors so that neighbors may live in harmony together instead of forcing one neighbor to relocate. Applying the *Mitamura*–Japanese Civil Code analysis to the situation of the upwind developer and downwind developer hypothetical discussed above, the upwind developer would be called upon to take the moral high ground by acting with integrity and honor, taking responsibility for its actions in a socially reasonable manner. Acting in such manner would entail employing the *Kenri no ranyo* doctrine, where the upwind developer may need to (1) exhibit restraint in exercising its right to situate its turbines less than a reasonable, minimum fixed distance away from the property line where its adjacent downwind developer neighbor is placing or has placed its turbines, or (2) exhibit restraint in operating its turbines so that they run in a manner that does not severely impede the downwind developer's ability to access reasonable levels of wind for its turbines. More specifically, this could mean that the upwind developer could be legally proscribed from abusing its right to operate its turbines, for example, by being required to run its turbines at a slower speed or curtail the turbines by turning them off during certain hours. By taking these measures, the upwind developer's turbines will generate a reduced amount of wake effect, thereby impacting the downwind developer's turbines less severely than would have been the case in the absence of such measures. The upwind developer, under a *Mitamura* construction, would be deemed to have acted in a socially acceptable manner because the upwind developer's actions are geared toward reducing the adverse impact on the downwind developer's property and toward mitigating against the upwind developer's actions having a disproportionately damaging impact on its downwind developer neighbor.

Japan's Building Standard Law (BSL) of 1950, as amended by the "Sunshine Amendment" of 1976[125] also illustrates how conflicts concerning light obstruction are resolved in Japan.[126] Under the BSL, there are numerous mechanisms allowing for conflict resolution between developers and homeowners through face-to-face negotiations and mediation. By encouraging discourse among

125. Building Standard Law Amendment No. 35 of 1978, Law No. 86 (Nov. 15, 1976) (Japan) (amending Building Standard Law, May 24, 1950, Law No. 201) (enforced by Cabinet Order No. 265 (1977)).

126. Seeley, *supra* note 114, at 713–14.

developers and impacted neighbors, stakeholders are encouraged to resolve sunlight obstruction concerns through non-judicial problem-solving methods that do not involve a default system of fines or other monetary damages payments.[127] Moreover, under the BSL, a builder and single homeowner have the option of expanding their bilateral negotiations into multilateral negotiations with other impacted neighbors, so that a multilateral contract may be executed that binds all stakeholders who agree to abide by the decisions set forth in the contract.[128]

Taken as a whole, *Mitamura*, the Japanese Civil Code, and the BSL are all instructive for modern-day adjacent landowners and wind developers in the United States insofar as how their respective approaches to allocation of rights to sunlight may be applied to wind rights. Applying the doctrine of "abuse of right," an upwind developer would be forced to act in a socially responsible manner, even though such developer may have the right to access winds blowing across a given parcel. Specifically, the upwind developer would be required to erect and operate its turbines in a manner considerate of the potential adverse impacts such actions may have on the adjacent downwind developer and that would minimize the adverse impact on the downwind developer's contemplated or already-existing turbines. The Japanese Civil Code's requirement that one's actions be judged with respect to one's neighbor and to the greater social order encourages parties to exercise their rights in a manner facilitating the harmonization of interests on both an individual level and on a broader, communal level. Within this context, a statute or other legal standard would need to consider not only how a developer's actions will impact its adjacent neighbor both presently and in the future, but also how such actions will impact the greater community that is the intended beneficiary of the potential power from both developers' respective turbines. Moreover, the BSL's encouraging expansion of bilateral negotiations to include multilateral negotiations among impacted neighbors should also be employed in the context of wind developers, adjacent neighbors, and the local community to strike the most favorable balance among directly impacted stakeholders.

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127. *Id.* at 714–15, 719.
128. *Id.* at 717.

2. Foundational Theories Impacting British Access to Sunlight Law

British access to sunlight regulation is also instructive from a lessons-learned perspective, as it provides additional legal theories on which domestic wind rights regulations, ordinances, and other legal constructs may be based. British law with respect to sunlight access also evolved out of the common law and the statutory codification of common law constructs. Solar access laws emerged in England with the Doctrine of Ancient Lights. Under this doctrine, a landowner can acquire an easement by prescription to the unobstructed use and enjoyment of sunlight that streams across an adjacent neighbor's property if such landowner enjoyed uninterrupted use of the light for a period of twenty years.[129] This doctrine was codified both in the Prescription Act of 1832[130]—the first statute to protect light easements with a prescriptive period of twenty years, and the Rights of Light Act of 1959[131]—enacted to protect the right to sunlight of landowners whose property had been destroyed in World War II.[132] The Prescription Act was significant insofar as it addressed the amount of light that could be acquired by prescription.[133] The basis of this Act was nineteenth century sunlight litigation case law wherein plaintiffs had the burden of proving that they sustained material injury from their loss of sunlight access.[134] "Materiality" was demonstrated by a showing that, due to the severity of diminution of light reaching the plaintiff's property, the property at issue was rendered materially less suited for habitation or production.[135] A plaintiff's showing of either a mere alteration or an unquantified diminution of light was deemed an insufficient injury for that plaintiff to prevail.[136] The difficulty with

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129. *Id.* at 690–91.

130. 2 & 3 Will. 4, c. 71, § 3 (Eng.), *available at* www.legislation.gov.uk/ukpga/Will4/2-3/71. The Prescription Act states that "When the access and use of light to and for any dwelling house, workshop or other building shall have been enjoyed for the full period of twenty years without interruption, the right thereto shall be deemed absolute and indefeasible, any local use or custom to the contrary notwithstanding, unless it shall appear that the same was enjoyed by some consent or agreement expressly made or given for that purpose by deed or writing." *Id.*

131. 7 & 8 Eliz. 2, c. 56, § 1–8 (Eng.).

132. Seeley, *supra* note 114, at 690–91, 694 (describing the Prescription Act of 1832 and the Rights of Light Act of 1959).

133. Seeley, *supra* note 114, at 693.

134. *Id.*

135. *Id.*

136. *Id.*

such a standard was that unless the presiding judge saw the property, that judge was not in a position to determine whether the plaintiff was "substantially deprived" of sunlight, or whether enough light remained for "beneficial use and enjoyment" of the property.[137] As a result, the outcome of such cases often rested on the persuasiveness of the pleadings submitted, as well as the discretion and motivations of the presiding judge.[138]

The 1904 landmark case of *Colls v. Home & Colonial Stores*[139] was an improvement over the Prescription Act because it set a clearer standard for establishing the impact of diminution in access to sunlight on an adjacent landowner's business. Specifically, Lord Lindley of the House of Lords clarified that, while the standard as applied to a dwelling was what would be considered sufficient "according to ordinary notions of mankind for comfortable use and enjoyment,"[140] as applied to a business, the standard was the amount of sunlight deprivation such adjacent landowner sustained that prevented the landowner from carrying on business as beneficially as it had done prior to the deprivation.[141]

Following *Colls*, a more popular standard known as the "grumble line" emerged from the 1922 case of *Charles Semon & Co. v. Bradford Corp*.[142] The grumble line was intended to identify the point at which the extent of diminished light in a room became so poor that "ordinary common sense people would begin to grumble" about the lack of light.[143] A room could therefore be divided into areas that fell either above or below the grumble line, and equitable relief in the form of an injunction could be issued or monetary damages could be assessed accordingly.[144]

A further step toward protecting an adjacent neighbor's right to sunlight was made in the 1979 case of *Allen v. Greenwood*,[145] which established the right to a "direct sunlight" prescriptive easement.[146] The difference between the standard established in Allen and its

137. *Id.*
138. *Id.*
139. [1904] A.C. 179 (H.L.).
140. *Id.* at 208; Seeley, *supra* note 114, at 694.
141. Seeley, *supra* note 114, at 693–94.
142. [1922] 2 ch. 737, 747–48.
143. Seeley, *supra* note 114, at 696.
144. *Id.*
145. [1980] 1 ch. 119.
146. Seeley, *supra* note 114, at 697.

predecessor cases was that *Allen* recognized a right to an extraordinary amount of light, rather than to just a reasonable amount of light for ordinary use as under the *Colls* standard.[147] More importantly, whereas the *Colls* and *Semon* cases set standards for rights to sunlight that were largely related to indoor lighting, *Allen* set standards for outdoor lighting.[148] *Allen* is notable because it was the first British case that addressed the importance of both the illumination and heat characteristics of sunlight, and it established a prescriptive right that includes both light and "heat or other energizing properties of the sun."[149]

British precedent governing solar rights may be helpful for establishing United States wind rights standards insofar as quantifying the amount of wind to which a downwind developer is entitled. First, the Prescription Act codified the requirement that a landowner quantify the amount of light the landowner needs so that a determination of material damage could be made with respect to that person's property. As applied to an adjacent downwind developer's access to wind, the Prescription Act is conceptually relevant insofar as it requires the developer to demonstrate a quantifiable amount of damage that the wake effect from an adjacent, upwind turbine could cause. Under a Prescription Act analysis, the downwind developer would have the burden of proving that the upwind developer's turbine rendered the downwind developer's turbine *materially* less suited for wind energy production. This more rigorous standard would require the downwind developer to affirmatively demonstrate through use of data from technologies such as SODAR, LIDAR, Supervisory Control and Data Acquisition (SCADA), Wind Atlas Analysis and Application Program (WAsP), Large Eddy Stimulation (LES) software, or other technologically advanced wind wake-measuring software systems, that the upwind developer's turbine caused a substantial, adverse impact on the downwind developer's turbine. A downwind developer's merely proving that the upwind developer's turbine caused an unquantified amount of turbulent wind with diminished wind speed to flow to the downwind developer's turbines would be inadequate proof that the downwind developer was harmed materially.

147. *Id.*
148. *Id.* at 700.
149. *Id.*

Second, the *Colls* case's establishment of the "sufficient light" standard according to ordinary notions of mankind is significant as applied to wind developers. This is because the *Colls* standard suggests that as long as a downwind developer's turbines can access a "sufficient" amount of wind according to ordinary notions of sufficiency, then that downwind developer does not have grounds for damages or injunctive relief against its upwind developer neighbor whose turbines' wakes impact the downwind developer's turbine operations. Under *Colls*, however, the downwind developer may argue that if its business is monetarily impaired by the financial losses incurred at a per-turbine level from the diminished production output of a wake-effect-impacted turbine, then it has a cause of action against the adjacent upwind developer entitling it to compensation for the difference between the amount of natural energy received after diminution and the amount such landowner had beneficially received previously, when wind flowed to the turbine in the freestream. However, an upwind developer could counter by arguing that the holding in *Colls*, similar to the "grumble line" standard set in *Semon*, was explicitly intended to govern sunlight usage for indoor businesses, and therefore its findings and standards are inapplicable to situations involving outdoor usage.

Third, the *Allen* case's proposition that a landowner may be entitled to an "extraordinary amount"[150] of sunlight is relevant, insofar as its application could mean that a downwind developer may acquire a prescriptive easement entitling it to "extraordinary amounts," rather than to only "sufficient" amounts of wind that would have flowed to its property but for the actions of the upwind developer. In the present-day United States context, having a state or federal standard that quantifies and differentiates what constitutes a "sufficient" amount of wind and what constitutes an "extraordinary" amount of wind could have significant implications. The difference between what is sufficient and what is extraordinary could impact where an upwind developer sites its turbines on a tract of land adjacent to the downwind developer, and correspondingly, could determine how much financial loss the upwind developer may sustain in terms of the amount of time its turbines must be curtailed. As illustrated above through the facts of the FPL–Peak Wind dispute, these two factors could prevent the project from being constructed in the first place if the financial loss outweighs the financial benefit of

150. Allen v. Greenwood, [1980] 1 ch. 119, at 136–38.

building the project itself at that particular location. Therefore, British statutory and common law relating to rights to sunlight is instructive for U.S. wind developers, as these laws illustrate the importance of quantifying amounts of diminution in wind access that wake effect causes. Drawing bright line standards for determining what quantity of wind is reasonable for a developer to receive better enables impacted parties to determine when a right to wind is violated, and to determine whether the upwind developer wants to take the cost-benefit risk associated with such a violation.

IV. U.S. STATUTORY PRECEDENT FOR ACCESS TO SUNLIGHT AND SOLAR POWER REGULATION AS THE BASIS FOR WIND RIGHTS REGULATION

In the United States, a number of states have recognized the greater social and economic benefits of utilizing alternative energy. Some of these states have codified rights to solar access and the use of solar collection devices to promote solar power as an alternative energy.[151] To encourage landowners to erect solar collection devices, and to support the further use and development of solar power as an industry, these statutes grant a right to access sunlight during a fixed temporal period.[152] Comparing the theories underlying these statutes to concepts employed in Japanese and British solar rights law illuminates which similar concepts have been drawn upon, and for what reasons. The theories employed domestically for solar access rights lay the framework for potential extrapolation to wind access, allocation, and balancing of rights between adjacent developers.

A. New Mexico's Solar Rights Act

New Mexico's Solar Rights Act[153] governs the use of solar energy in the state. As evidence of the Solar Rights Act's policy aims, the statutory language itself states that "the state of New Mexico recognizes that economic benefits can be derived for the people of the state from the use of solar energy" and that "the actual construction and use of solar devices, whether at public or private expense, is properly a commercial activity which the law should

151. *See, e.g.*, Solar Rights Act, N.M. STAT. ANN. §§ 47-3-1 to 47-3-5 (1978); Solar Shade Control Act, CAL. PUB. RES. CODE §§ 25980–25986 (2010).

152. *See* N.M. STAT. ANN § 47-3-2; CAL. PUB. RES. CODE § 25980.

153. N.M. STAT. ANN. §§ 47-3-1 to 47-3-5.

encourage to be carried out, whenever practicable, by private enterprise."[154] The Solar Rights Act clearly recognizes "the right to use the natural resource of solar energy" as a property right known as a "solar right."[155] Landowners who have erected solar collectors on their property may claim a solar right, which is recognized as an easement appurtenant to such property.[156]

Several features of the Solar Rights Act bear highlighting. First, the Solar Rights Act recognizes and protects the rights of the first-in-time landowner who places solar collection devices on his or her property, mandating that "in disputes involving solar rights, priority in time shall have the better right."[157] Such a construct rewards the adjacent landowner who invests in and takes affirmative steps to harness alternative energy. Taking this one step further, the Solar Rights Act places authority in the hands of the state and local political subdivisions to extend a protected solar right to property owners who *propose* to place solar collectors on their property, even if structures on the adjacent landowner's property currently block access to the property owner's proposed solar collection site.[158] This particular aspect of the Solar Rights Act primarily focuses on maximizing the greater social good by providing solar energy to individuals or to the greater community at the potential expense of the adjacent landowner, whose prior appropriation right to sunlight would be trumped. In fact, the Solar Rights Act requires adjacent landowners to refrain from erecting structures that may block or impede sunlight from flowing to an adjacent neighbor who possesses a solar collection device.[159] This adds an interesting twist to the Japanese "abuse of right" doctrine of *Kenri no ranyo* illustrated through the ruling in the *Mitamura* case and through the application of the Japanese Civil Code. While the Japanese Civil Code considers

154. *Id.* § 47-3-2.

155. *Id.* § 47-3-4.

156. *Id.* § 47-3-8.

157. *Id.* § 47-3-4.

158. *Id.*

159. *Id.* Specifically, § 47-3-4(B)(2) of the Solar Rights Act states that "the state [of New Mexico] and its political subdivisions may legislate, or ordain that a solar collector user has a solar right even though a structure or building located on neighboring property blocks the sunshine from the proposed solar collector site." *Id.* § 47-3-4(B)(2). Also, § 47-3-11 imposes certain height restrictions on adjacent properties burdened by a solar right, so that the adjacent neighbor who possesses the solar right may only be impacted by a shadow from that person's neighbor's improvements that cast a shadow no greater than a "hypothetical fence ten feet in height located on the property line of the property on which the solar collector is located." *Id.* § 47-3-11.

rights of individuals against one another in the context of the prevailing social order, the Solar Rights Act focuses primarily, almost exclusively, on the utilitarian construct of promoting the greater good for the most people—in this case through alternative energy generation. As a result, the Solar Rights Act effectively dismisses the rights of the "non solar collector possessing" landowner in favor of the "actual or potential solar collector possessing" landowner. Harmonizing neighbors' interest, at both the individual and community level, is missing from this portion of the Solar Rights Act.

Second, the Solar Rights Act not only contains a temporal period for unobstructed access (between 9:00 a.m. and 3:00 p.m.), but it also contains a "safe harbor" provision that allows improvements on a neighboring parcel that blocks ten percent or less of a landowner's "collectable solar energy" during the unobstructed access period.[160] The temporal and safe harbor elements of the Solar Rights Act are significant for the following reasons: First, the temporal concept draws on the British common law notion of being able to quantify the amount of access an individual landowner has to sunlight during a given period. Second, the safe harbor provision illustrates the British notion of setting a reasonable limit, or a "permissible diminution," on the amount of access to sunlight an adjacent landowner is deemed reasonably entitled to experience, with no legal recourse. The Solar Rights Act's codification of permissible diminution effectively mandates that the impacted landowner has no reasonable expectation of receiving an "extraordinary amount" of solar access. It also means that the impacted landowner has no right to compensation for the diminished future value of lost generation capacity that such person's solar collection device would have otherwise produced, had the device experienced one hundred percent unobstructed access to sunlight and had the device's collection capacity not been diminished by up to ten percent over a given period of time.

B. *California's Solar Shade Control Act*

California's Solar Shade Control Act[161] is similar to New Mexico's Solar Rights Act in several ways. First, like the Solar Rights Act, the Shade Control Act also encourages the use of alternative energy, stating that "[i]t is the policy of the state to promote all

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160. *Id.* § 47-3-11.

161. CAL. PUB. RES. CODE §§ 25980–25986 (2010).

feasible means of energy conservation and all feasible uses of alternative energy supply sources."[162] Second, the Shade Control Act similarly includes a temporal and safe harbor feature, mandating that a neighboring landowner may only cast a shadow (from a tree or shrub) on another neighbor's solar collector to the extent that it only blocks ten percent or less of the solar collector's surface between the hours of 10:00 a.m. and 2:00 p.m.[163] Third, the Shade Control Act contains a feature similar to the Solar Rights Act's provision that enables local jurisdictions to extend a solar right to landowners who propose placing solar collectors on their property, irrespective of structures that adjacent landowners may have already erected on their property.[164] The Shade Control Act mandates that for any person who builds a solar heating or cooling system on his or her property that adversely impacts an adjacent neighbor's pre-existing solar collector, if such second-in-time solar collection system "provide[s] a demonstrably greater net energy savings than the active system which would be impacted," then a court may exempt the second-in-time landowner from the adverse impacts his or her solar collector has on the first-in-time neighbor's solar collector.[165] This means the adversely impacted first-in-time landowner (1) has no recourse against the second-in-time neighboring landowner for minimally, substantially, or completely impairing such already-existing solar collector, and (2) has no reasonable expectation of being able to enforce a legal right against such neighbor for damages suffered in the form of lost future value of generation capacity that such solar collector would have otherwise produced but for such second-in-time neighbor's solar access interference. As there is no cap on the amount of obstruction the second-in-time solar device may cause to the first-in-time neighbor's collection device, the second-in-time neighbor is not bound by fixed limits of obstruction. The failure to implement a well-defined cap, theoretically, could potentially allow the second-in-time neighbor to obstruct its first-in-time neighbor's solar device enough to render it completely useless.

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162. *Id.* § 25980.

163. *Id.* § 25982.

164. *See id.* § 25986; N.M. STAT. ANN. § 47-3-4(B)(2).

165. CAL. PUB. RES. CODE § 25986.

C. Lessons Learned from New Mexico's Solar Rights Act and California's Solar Shade Control Act, as Applied to the Formulation of Wind Rights Policies

Both positive and negative lessons from the Solar Rights Act and the Shade Control Act can be extrapolated to the formulation of policies for wind rights governance. First, both Acts encourage and promote the development of alternative energy harvested through privately-owned collection devices. Second, and more significantly, both Acts establish temporal and safe harbor elements that set acceptable diminution levels for access to the natural resource in question. If these concepts were applied to wind, developers would have a fixed, bright line limit to guide expectations about the legally acceptable level of wind diminution, regardless of whether potentially downwind turbines are erected before or after an upwind neighbor erects turbines. For instance, if wind-wake-measuring technologies and programs were used to predict and measure wake effect between an upwind turbine and a downwind turbine, the amount of diminution in ambient wind flow to the downwind turbine could be quantified, or at least reasonably approximated. Alternatively, from the upwind developer's perspective, with these legal guidelines in place, having an adjacent downwind developer neighbor who already has turbines erected on the adjacent property may not be a deterrent to turbine construction. This is because the upwind developer would be on notice for the maximum amount of wake effect impact it could cause, and could use wind-wake-measuring technologies to plan ahead accordingly, so that this maximum limit is not exceeded. Based on these calculations, the upwind developer could site, configure, curtail, or select two or all of these measures so that the wake effect from its turbines only at most causes the fixed, statutorily permitted amount of diminished wind to flow to its downwind developer neighbor's turbines.

The absence of a bright line limit for acceptable diminution levels is problematic for purposes of establishing wind rights. For instance, Wisconsin's statute governing solar and wind access permits ("Wisconsin Statute")[166] deems sunlight and wind similar enough in characteristics to have the equivalent measures applied to their regulations and usage, and to have landowners' rights defined by the same exceptions and other factors for each. The issue with the

166. WIS. STAT. ANN. § 66.0403 (2010).

Wisconsin Statute is that while it contains a temporal element for a "collector use period" (9:00 a.m. to 3:00 p.m.) and states that "impermissible interference" is not allowed with respect to solar or wind collection devices during such time, there is a flaw in the definition of "impermissible interference."[167] Like the British Prescription Act that did not qualify what specifically constituted an acceptable level of diminution in light, the definition of "impermissible interference" does not specify a specific percentage of interference that constitutes an acceptable interference level. In contrast to New Mexico and California solar legislation, which establish bright line percentage levels, the Wisconsin Statute's omission of a clearly defined threshold prevents a safe harbor from being established, which adjacent upwind developers and downwind developers could otherwise use to project potential levels of acceptable wake effect levels and wind speed diminution. With the absence of such safe harbor, developers may find themselves facing the types of construction-related dilemmas and choices discussed in part II above. The establishment of fixed diminution levels during a set, temporal time period, therefore, could act as a turbine construction benchmark for both the upwind developer and downwind developer.

The New Mexico and California solar acts are also instructive for illustrating areas on which ideal wind rights guidelines could improve. For instance, the Solar Rights Act gives the first-in-time alternative energy collection device builder an advantage over its adjacent neighbor in terms of gaining protected access rights in the form of easements.[168] This first-in-time construct disregards the fact that the other second-in-time adjacent landowner potentially could produce more energy than the first-in-time landowner through the installation of similar or improved devices on its property. This construct also does not take into account whether the first-in-time builder is located closer to already-existing grid interconnection lines, which more readily could facilitate energy transmission to others. The Shade Control Act illustrates the pitfalls of the flip side of this scenario. Under the Shade Control Act, whichever adjacent landowner's alternative energy collection device produces the greatest energy savings, the access rights of the landowner who owns such device

167. *Id.* § 66.0403(1)(e), (f).

168. *See* N.M. STAT. ANN. § 47-3-4(B)(2) (1978) (exception to prior appropriation for solar collector site) and § 47-3-8 (establishing a solar right as an easement appurtenant).

trump those of its neighbor.[169] In a situation with adjacent wind farm developers, this could be disastrous for either the upwind developer or the downwind developer, as they could each face some of the predicaments discussed previously in part II, insofar as whether to build or forego construction, given the risk that their developer neighbor may at some point erect adjacent wind turbines that generate more energy than their own turbines.

Moreover, the state solar acts effectively disregard the Japanese construct of harmonization of rights among adjacent neighbors. Both acts advocate the promotion of alternative energy, no matter the potential cost to the adjacent neighbor. Under principles of fairness, as well as the goal of not pitting one neighbor against the other, such provisions are not optimal. In contrast to the New Mexico and California legislation, ideal wind rights policies and guidelines would be similar to Japan's 1976 Amendment to the BSL, incorporating directives encouraging or mandating multilateral negotiations among neighbors and other stakeholders that the wind farm project most substantially impacts ("stakeholder collective negotiations"). Such policies and guidelines would also encourage these parties to enter into contracts using suggested or mandated limits, or to contract out of such limits by establishing fair, contractually negotiated work-arounds.

V. OTHER POLICY CONSIDERATIONS FOR SAVVY PARTICIPANTS: PROVISIONS ON WHICH TO FOCUS IN WIND ENERGY LAND LEASE AGREEMENTS

A. The Short-Term Option Period and the Long-Term Lease Period

Similar to stakeholder collective negotiations, certain aspects of wind rights that typically remain two-party oriented, such as the process of negotiating wind energy land lease agreements ("wind lease agreements"), should also be broadened to include other stakeholders. The wind lease agreement is the primary legal contractual document between a wind facility developer and a landowner.[170] This agreement is the long-term contract entered into

169. *See* CAL. PUB. RES. CODE § 25986 (2010).

170. Since much wind development takes place on lands zoned for agriculture production, several state agriculture agencies and advocacy organizations have developed tools detailing wind leases. *See, e.g.*, STEPHEN B. HARSH ET AL., DEP'T OF AGRIC., FOOD & RES. ECON., MICH. STATE UNIV., LANDOWNER GUIDELINES FOR EVALUATING WIND ENERGY

between a landowner and a developer, after the developer completes an option period. An option period is a pre-construction period that is generally three to five years long during which the developer conducts wind resource and other feasibility testing to determine whether to move forward with turbine construction on a particular parcel.[171] From a landowner's perspective, the length of the option period should be limited and should not extend longer than a reasonable period, which the wind industry has come to accept as having an upward cap of five years.[172] There are generally two ways to contractually cover the option period. The first way is to have a separate option contract that covers the option period with a stand-alone wind lease agreement that covers only the long-term lease phase for the energy production period and does not cover the option period. The second way is to have the wind lease agreement contain both the short-term option contract and the long-term lease contract for the energy production period.[173]

Whether or not the option contract is separate from or contained in the wind lease agreement, landowners should always request formal lease documents that clearly state all terms and conditions, including amount, frequency, and duration of lease payments; number and type of facilities located on each lessee's property; expected duration of construction and operation of the facility; and agreed-upon setbacks.[174] Landowners should have these legal documents reviewed by an attorney familiar with wind leases to ensure that their rights are protected appropriately.

PRODUCTION CONTRACTS (2008), *available at* http://www.michfb.com/files/ecology/Worksheet%20for%20Evaluating%20Wind%20Leases.pdf; ROBERT R. NARDI & JOHN H. DANIELS, JR., WIND EASEMENT WORK GROUP, WINDUSTRY, WIND ENERGY EASEMENTS AND LEASE AGREEMENTS (2005), *available at* http://www.windustry.org/sites/windustry.org/files/LandEMain.pdf.

171. *See* GLOBAL ENERGY CONCEPTS, SAMPLE ANNOTATED LAND LEASE AGREEMENT 3 (2005) [hereinafter Sample Lease Agreement], *available at* http://www.retscreen.net/fichier.php/1573/14b_windenergyleaseagreement.pdf; Judon Fambrough, *Wind Rights and Wrongs*, TIERRA GRANDE, Apr. 2008, at 1, *available at* http://recenter.tamu.edu/pdf/1856.pdf.

172. WIND EASEMENT WORK GROUP, WINDUSTRY, WIND EASEMENTS AND LEASES: BEST PRACTICES AND POLICY RECOMMENDATIONS 2 (2005), http://www.windustry.org/sites/windustry.org/files/LandEBestPractices.pdf.

173. *See* NARDI & DANIELS, *supra* note 170, at 3; Fambrough, *supra* note 171, at 1.

174. NARDI & DANIELS, *supra* note 170, at 4–7.

B. Non-Obstruction Easements, No Interference Covenants, Indemnity Provisions, and Negative Covenants with Respect to Third Parties

As wind lease agreements can span a term of twenty to forty or more years,[175] in addition to the developer and landowner, other impacted parties such as investors in the project, financing sources, and power purchasers will want to ensure that sufficient provisions are contained in the wind lease agreement that will allow for unimpeded access to use of the land and wind access during the life of the contemplated project.[176] Accordingly, wind lease agreements may contain corollary non-obstruction easement sub-agreements that are filed with the county in which the parcel is located or with another appropriate local authority for registering and recording easements.[177] The rationale behind having an easement in addition to a lease relates to the distinction between a lease and an easement. A lease conveys an exclusive, possessory right to a party for a parcel or property for a fixed period of time during which period certain conditions of use must be satisfied, while the property owner or lessor retains legal title to the property.[178] In contrast, an easement does not grant a possessory right to the land by conferring title to that land or by creating a lien on it, but conveys only a narrow right for the party to have limited use of a particular portion of the landowner's property,[179] or a right to take something off the landowner's land.[180] A non-obstruction easement is intended to grant the developer a right to unobstructed access to wind flowing across a particular parcel, which includes protecting the project site against wake effect from the upwind developer's turbines, or any other obstructions on the landowner's parcel that may impede the speed or direction of wind flowing over that parcel.[181] This means that if a landowner owns a vast tract of land, if the landowner enters into a non-obstruction easement with a particular developer, the landowner would be legally

175. *Id.* at 5.

176. *Id.* at 3.

177. *Id.* at 5; Kathleen K. Law, *Wind Power: Developing Real Property for a Wind Project*, PROB. & PROP., July–Aug. 2009, at 59.

178. STEVEN H. GIFIS, BARRON'S LAW DICTIONARY 307 (7th ed. 2010); BLACK'S LAW DICTIONARY 461 (5th ed. 1983).

179. Sample Lease Agreement, *supra* note 171, at 5 n.1; Law, *supra* note 177, at 58.

180. CHARLES M. HAAR & LANCE LIEBMAN, PROPERTY AND LAW 912–13 (2d ed. 1985).

181. *See* Sample Lease Agreement, *supra* note 171, at 5; Law, *supra* note 177, at 59.

prohibited from entering into a contract with another upwind developer if the wake effect from the upwind developer's turbines' impacted in any way the wind flowing to the original developer's (now, the downwind developer's) turbines. The term for these kinds of easements should extend for no longer than the life of the project, or about thirty years, rather than for a longer term or a perpetual term. This term length allows landowners or those inheriting the land burdened by the easement to renegotiate the easement terms at a later date.

To further protect against an upwind developer and downwind developer scenario, the developer should consider requiring the landowner to agree to a "No Interference" representation or warranty, an "Indemnification" provision, and a "Negative Covenant" with respect to third parties, in the "Representations and Warranties" section of the wind lease agreement. A "No Interference" provision requires the landowner to affirm to the developer that none of the landowner's activities, either with respect to the leased parcel in question or with respect to other parcels the landowner owns, shall interfere at present or in the future with the wind speed or wind direction over the leased parcel, including activities that could cause a decrease in the energy output or efficiency of the turbines to be located on the leased parcel.[182] Such a provision may also include carve-out language for structures built for agricultural use in the ordinary course of the landowner's business (for instance, a silo) that interfere with the wind speed or wind direction over the leased parcel, as long as the landowner is required to obtain the developer's prior written consent for these structures, which may be withheld at the developer's sole discretion.[183] Moreover, an "Indemnification" provision puts the burden on the landowner to compensate the developer for any damages, losses, or expenses (including reasonable attorneys' fees) that the developer incurs as a result of the landowner's or its other tenants' activities. Additionally, a "Negative Covenant" with respect to third parties may require the landowner to refrain from contracting with a third party for power generation or transmission across the leased property.[184] These provisions would each provide added assurance to the developer that its turbines will not experience wake effect from upwind turbines, as

182. *See, e.g.*, Sample Lease Agreement, *supra* note 171, at 15.

183. *See, e.g.*, *id.*

184. *Id.* at 16.

each provision is aimed at preventing the landowner from contracting with an upwind developer who could erect upwind turbines on the landowner's property at a later date.

A landowner, therefore, should consider how to maximize the future potential use of its parcel with respect to wind turbine siting or a future wind tower, cell tower, or silo location on such parcel, and should consider how to preserve a certain measure of control over the parcel, prior to entering into obstruction easements or negotiating a wind lease agreement. Similarly, a developer should consider requiring the landowner to agree to an obstruction easement, and, if possible, should consider leasing most or all of the landowner's property. Doing so will permit the developer to control the siting of each turbine on the property and—taking into account factors such as wake effect—allow the developer to maximize the efficiency and productivity of each turbine it erects on the property.

C. Payments to the Landowner

Once a developer decides to erect a turbine on a particular parcel and enters into a wind lease agreement with the landowner, the developer pays that landowner a particular amount ("rent") for the leased parcel on which the turbine will be sited. A frequently used method of rent payment under wind lease agreements is royalty payments. In this context, a royalty payment is defined as either a percentage of gross revenue that the turbines generate, or a fixed amount paid for every unit of energy generated.[185] Royalty payments may be a one-time, lump-sum payment, or they may be separate, periodic, fixed payments made in regular intervals over a given period of time.[186] Payments to a landowner may be based on the average amount of energy a developer's wind turbines on the landowner's parcel produce, or may be based on meter readings at each individual turbine.[187] The latter method of payment calculation is a more risky method for the landowner, as a poorly performing turbine (impacted by wake effect, turbine reliability, or other factors) may reduce the overall compensation such landowner receives.[188]

185. *See id.* at 10; Fambrough, *supra* note 171, at 2.

186. Sample Lease Agreement, *supra* note 171, at 10.

187. *Id.*

188. *Id.* To protect against turbine underperformance, a land owner may want to negotiate a minimum royalty provision in the wind lease agreement so that the landowner is effectively guaranteed a per-turbine minimum annual income. *See* Fambrough, *supra* note 171, at 4.

While periodic rent payments are generally used as the preferred means of landowner compensation, landowners should also consider forms of non-monetary compensation that may be beneficial to their property. For instance, a landowner can bargain with the developer for certain infrastructure improvements on such landowner's property. These improvements may help increase the value of the landowner's property, and can mitigate against the landowner bearing the sole cost burden associated with the improvements.

D. Downfalls of Negotiating a Lease Without Community Input

Because each wind lease agreement is negotiated between a single landowner and a wind project developer, one landowner may potentially strike a less favorable deal than a neighboring landowner with the same developer. Even under such a scenario, in most instances, the developer nevertheless still holds the superior bargaining position relative to any landowner, because developers have significant resources at their disposal such as land acquisition and contracts specialists. Savvy developers may seek to minimize their contractually negotiated costs under wind lease agreements even though the total costs associated with wind rights and wind leases for a project are relatively small compared to the overall cost of the project.[189]

Once again, drawing upon the policy rationale behind Japan's 1976 Sunshine Amendment to the BSL, savvy landowners should consider broader community involvement to negotiate specific provisions in wind lease agreements in ways that maximize their gain and limit individual liability. In certain areas of the United States, landowners have already begun implementing such actions by forming a unique type of collective bargaining group, called a landowner wind energy association (LWEA).[190] LWEAs may engage multiple developers in a competitive bidding process, whereby all impacted landowners receive similar compensation, all transactions are transparent, all participants have an adequate understanding of the wind lease agreements they are signing, and mutually beneficial contract terms can emerge for both the lessors and lessees under such contracts. An additional benefit to developers that LWEAs afford is that landowners who enter into an LWEA generally support wind

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189. *See The Economics of Wind Energy*, RENEWABLE U.K., http://www.bwea.com/ref/econ.html (last visited Jan. 7, 2012) (showing breakdown of capital costs for wind energy).

190. WINDUSTRY, INTRODUCTION TO LANDOWNER WIND ENERGY ASSOCIATIONS 1 (2006), http://www.windustry.org/sites/windustry.org/files/Introduction_%20to_LWEA_0.pdf.

facility development and can positively impact a community's receptiveness toward wind power development. This is significant, as a community's support and positive sentiment toward wind power development are essential to a wind project's success. Landowners and developers alike, therefore, should consider entering into LWEAs to maximize the overall profits tied to wind leases that flow to landowners in a particular community and to generate a foundation of positive community support for wind turbine development in that community.

Landowners stand to benefit when wind leases are crafted properly. However, landowners also may face additional burdens associated with the development, construction, ongoing operations, and maintenance of wind facilities on or adjacent to their property. To protect themselves, landowners should consider several additional or alternative provisions beyond land lease payments with respect to compensation they receive from developers for use of their land. First, developers should consider infrastructure improvements in lieu of payments. For example, developers often improve roads to accommodate turbine component deliveries. While developers utilize these roads for a small period of time, landowners and localities reap the benefits of wider, stabilized roads for years to come. These benefits may be used as a bargaining tool for reducing the number and amount of overall lease payments. Second, developers should contract with landowners for associated services such as gravel quarries, water rights, and cement batch plant locations. Defining the parameters of such services in a written agreement sets the expectation for both landowner and developer regarding these services, may reduce the distance and logistics the developer needs to haul construction materials, and may provide the landowner with additional payments for these services.

E. U.S. Statutory Precedent Promoting Fair Wind Lease Terms

1. Minnesota's Next Generation Energy Act

In May 2007, Governor Tim Pawlenty signed the Minnesota Next Generation Energy Act of 2007 into law.[191] This legislation provides statutory limits on the length of wind lease terms that appear in wind lease agreements. The Next Generation Energy Act requires

191. 2007 Minn. Laws ch. 136 (S.F. No. 145).

developers to begin construction in a reasonable amount of time and restricts developers to an option period of seven years in which to begin construction on a wind facility, or the landowner may be released from the agreement.[192]

The Next Generation Energy Act also increases the number of megawatts over which counties have permitting authority from 5 to 25 MW.[193] This change provides greater land use control to localities and gives counties a seat at the decision-making table for small commercial developments. Counties are also able to impose standards that are more stringent than those imposed under state law.[194]

2. North Dakota's House Bill 1509

In April 2009, North Dakota's House Bill 1509[195] was introduced to require the North Dakota Public Service Commission to adopt a set of voluntary conduct guidelines to limit the duration of wind lease terms, mandate "clear and coherent language," and prohibit confidentiality clauses, which prevent neighbors from sharing details about their respective wind lease agreements.[196] The aim of this bill was to address uninformed lessors' potentially diminished ability to negotiate for the fair-market value of their parcel of land. For example, imagine a scenario where a home seller did not know the selling price of any nearby, similar homes. The seller in this instance, akin to the landowner, would undoubtedly be at a disadvantage in setting a fair selling price for his or her home. The final version of H.B. 1509 allows landowners to discuss the terms of the contract up until the time that the landowner signs the agreement.[197]

Increased transparency is an important aspect of relative fairness when multiple leaseholders are involved. Standardized wind lease

192. *Id.* ch. 136, art. 4, § 15; *see* Lisa Chivarria, Panel Discussion at the Wind Energy Institute: Wind Leases: Emerging Issues (Feb. 19–20, 2008) (PowerPoint Presentation) (on file with DUKE ENVTL. L. & POL'Y F.). *See generally* Press Release, Windustry, Next Generation Energy Act Helps MN Farmers and Small Businesses Build Renewable Energy Projects (May 25, 2007) [hereinafter Windustry Press Release], *available at* http://www.windustry.org/sites/windustry.org/files/CBED_release.pdf.

193. 2007 Minn. Laws ch. 136, art. 4, § 13.

194. *Id.*; Windustry Press Release, *supra* note 192.

195. H.B. 1509, 61st Leg. Assem., Reg. Sess. (N.D. 2009).

196. *Id.*; Dale Wetzel, *Wind Lease Restrictions Approved in ND Legislature*, BISMARCK TRIBUNE, Apr. 30, 2009, *available at* http://bismarcktribune.com/news/state-and-regional/article_962256e2-b7cd-51fe-bb32-634b90d95770.html.

197. H.B. 1509.

agreements provide developers with a homogeneous set of terms and obligations, which can easily be tracked throughout the life of a project. However, not all standardized lease conditions may provide adequate compensation or risk limitations for all leaseholders. When an uninformed landowner signs a standardized wind lease agreement containing insufficient terms, that landowner's execution of the form contract makes it more difficult for the landowner's neighbors to negotiate changes to the terms of their own wind lease agreements.[198]

H.B. 1509 also states that the landowner is not liable "for any property tax associated with the wind energy facility or other equipment related to wind energy generation" or for "any damages caused by the wind energy facility and equipment or the operation of the generating facility and equipment, including liability or damage to the property owner or to third parties."[199] This provision limits the landowner's liability in case of decommissioning, vandalism, theft, or other disturbance to the facility. The bill also requires that the landowner be released from the wind lease agreement if the wind farm development is not operational for three or more years and guarantees the normal minimum payment for those years when the project could have been operational.[200]

Finally, the legislation requires wind lease agreements to contain a "cover page" recommending that those entering into the agreement retain legal representation. While such a recommendation seems obvious to a savvy participant, in the state of North Dakota, physical distance to legal counsel presents a significant barrier. Those landowners with access to legal counsel may find that nearby attorneys may not have experience negotiating wind lease agreements, resulting in these landowners having a distinct disadvantage when negotiating their rights and other adequate protections under these agreements. Considering that North Dakota is one of the top states for domestic wind energy production,[201] the implications of inadequate legal representation and, consequently,

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198. *See* Colleen Rice, *North Dakota Century Code Section 17-04-06: The First Step Toward a Level Playing Field for Wind Projects and Rural Landowners*, 85 N.D. L. REV. 723, 729 (2009) ("Any trusting landowner who signs a form wind easement containing unfair terms makes it more difficult for his neighbors to negotiate changes.").

199. H.B. 1509.

200. *Id.*

201. *See* AWEA MARKET OUTLOOK, *supra*, note 3, at 4.

potentially inadequate protections negotiated for impacted landowners in that state are substantial.

Not surprisingly, H.B. 1509 received considerable input from the wind industry, famers unions, and rural landowners, which resulted in several amendments by both North Dakota's House and Senate Natural Resources Committees. The final version of H.B. 1509 passed the House on April 29, 2009, passed the Senate the following day on April 30, 2009, was signed by the governor on May 4, 2009, and was codified in the North Dakota Century Code as section 17-04-06, effective as of August 1, 2009.[202]

F. Lessons Learned from the Minnesota Next Generation Energy Act and North Dakota's House Bill 1509, as Applied to Wind Rights Policies

Both positive and negative aspects of the Next Generation Energy Act and H.B. 1509 can be extrapolated to policies for wind rights governance. The positive aspects of both pieces of legislation are as follows. First, both pieces of legislation restrict the length of time a wind lease can be held. Wind leaseholders should have the option to renegotiate the terms of the lease upon project decommissioning or repowering. To protect developers, the terms of the wind lease should remain consistent throughout the life of the project. Second, both pieces of legislation increase local jurisdictions' ability to participate in the decision-making process. While state agencies may have greater resources to devote to siting analysis and scrutiny, allowing localities to participate in decisions directly affecting the surrounding community provides a positive atmosphere for developers and landowners alike. Finally, both pieces of legislation reduce overall tax liability for landowners and landowners' liability for damages that may occur on their parcel.

More critically, there is one negative aspect concerning both pieces of legislation: neither piece provides unconditional transparency in terms of the content of individual wind lease agreements. Under principles of fairness and similar principles referenced above in Japan's solar access laws, providing all landowners with equal footing for negotiations creates more ideal wind rights policies and guidelines. As noted above, by encouraging or mandating multilateral negotiations among neighbors who are most substantially impacted by the turbine project (such as through

202. N.D. CENT. CODE § 17-04-06 (2011); *see* Rice, *supra* note 198, at 738–40.

LWEAs) wind lease agreements increase profitability for landowners and decrease the time invested in negotiating leases for developers.

G. Cumulative Impact Concerns Pose Future Implications for Adjacent Landowners and Developers

While wake effect presents the bulk of technological challenges associated with siting turbines and associated facilities, future legislation may also require consideration of cumulative environmental impacts of wind developments. This additional hurdle may pose further constraints to wind energy development. Wildlife effects may be magnified when several wind developments are clustered in areas with valuable wind resources. Infrastructure such as roads and transmission lines can fragment the landscape, affecting some wildlife.[203] Also, those generally opposed to large-scale or adjacent wind projects cite cumulative impacts associated with traffic, visual, radar, and noise disturbances as reasons to decry such projects.[204]

Agencies, industry, and universities alike continue to study these concerns. While little conclusive evidence exists that suggests large-scale or adjacent developments pose a greater threat than smaller developments, some state or local jurisdictions may require cumulative environmental impact studies be undertaken prior to licensing authorizations for a wind project's development.[205] This, in turn, can create delays in permitting and construction timelines, further extending option periods for landowners and adding expenses to the overall project budget.

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203. *See generally* William P. Kuvlesky, Jr. et al., *Wind Energy Development and Wildlife Conservation: Challenges and Opportunities*, 71 J. OF WILDLIFE MGMT. 2487 (2007) (discussing the potential impact of wind turbines on wildlife populations).

204. Many editorials have been written about cumulative impact concerns. *See, e.g.*, Peter Collins, *The Sister Wind Farm Blow*, THE WARRNAMBOOL STANDARD, May 7, 2010, *available at* http://www.standard.net.au/news/local/news/general/the-sisters-wind-farm-blow/1823077.aspx?storypage=0; Gil Smart, *Tilting at Windmills*, THE LANCASTER ONLINE, May 2, 2010, *available at* http://articles.lancasteronline.com/local/4/252919; David Montgomery, *Military Officials Say Wind Turbines Can Stir Up Problems for Bases*, FORT WORTH STAR-TELEGRAM, Apr. 27, 2010, *available at* http://www.star-telegram.com/2010/04/27/2147388/military-officials-say-wind-turbines.html.

205. *See, e.g.*, U.S. FISH & WILDLIFE SERVICE WIND TURBINE GUIDELINES ADVISORY COMMITTEE, COMMITTEE RECOMMENDATIONS (2010), *available at* http://www.fws.gov/habitatconservation/windpower/Wind_Turbine_Guidelines_Advisory_Committee_Recommendations_Secretary.pdf.

CONCLUSION

Wind turbine wakes, wake effect impacts, and wind lease agreements are all critical components factoring into wind turbine siting, spacing, and construction at a given location that both developers and landowners should consider before erecting wind turbines on a particular parcel. Wake effect's impact on downwind turbines' productivity can have a significant impact on both the amount of profits a turbine generates, as well as on decisions relating to commercial wind turbine location. Wake modeling software and programs may assist in measuring wind wakes and their downwind effects. However, these programs may be cost-prohibitive and inaccessible to landowners who have commercial wind turbines on their property and whose profits from these turbines may be adversely impacted. Moreover, developers who have access to such technologies may be deterred from building turbines on certain parcels unless certain minimum setback distances between turbines are instituted, or until more concrete guidelines relating to wind access rights relative to turbines sited on an adjacent neighbor's land are established.

Given the differences in population density, parcel size, jurisdictional requirements, and cumulative constraints, a one-size-fits-all policy approach may be inadequate. The best approach for governing rights associated with wake effect and rights to wind flow and wind access is to have wind rights standards evolve from similar regulations applicable to solar power that have been used abroad in Japan and Britain, and that are being used domestically in New Mexico and California. Ideally, new legal policies addressing wind rights on the federal, regional, and state levels should be formulated within a utilitarian framework, ensuring that the approach selected maximizes the greatest amount of clean, renewable energy generated from wind for the greatest number of people, balances fairly the rights of the most directly impacted parties such as developers and landowners, and sets bright-line guidelines for a reasonable diminution level. Finally, the statute should establish clear safe harbor provisions for adjacent upwind developers whose turbines create wake effect. These policies should also consider the rights of developers and landowners with respect to one another, as well as within the context of the greater community in which the turbines and parcels at issue are located. Moreover, the policies should encourage adjacent landowners to engage in negotiations together and with developers (as done in an LWEA), expand such negotiations to include other substantially impacted stakeholders, and enter into fully-negotiated, multilateral written contracts. The policies should also encourage transparency with respect to wind lease agreements and should suggest specific provisions that should be included in these agreements. While the formulation and implementation of such wind rights policies may take time, the positive long-term benefits achieved for developers, landowners, and impacted communities alike will be worth the wait.