REGULATING BACKYARD WIND TURBINES

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TABLE OF CONTENTS

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INTRODUCTION

With increasing concerns about global climate change, carbon footprints, sustainability, and the price of oil, everyone seems to be looking for alternatives to produce electricity.[1] Surprisingly, it is believed that there are only 4,000 residential small wind turbines in the country, so there remains the potential for rapid growth.[2] Wind power is the best alternative in terms of the lowest cost per kilowatt hour among technologies that are practical and reasonably available.[3]

Wind power is essentially solar power, though most people would not think of it in those terms. The heating and cooling of the earth from the sun, combined with the differences in the way the earth's surfaces gain, lose, reflect, and hold heat, results in the creation of differential pressures.[4] Air rising over heated surfaces creates low-pressure areas. The pressure is made even lower because of the lower density of heated air.[5] Cooler, denser air is pulled in to the low-pressure area.[6] The result? Wind.

Modern wind turbines can capture the power of the wind and convert it into electricity. Electric generators come in a wide variety of shapes and sizes, ranging from a few hundred watts, which might be used to provide additional power on a small boat or to run a water pump in a distant farm field, to a fifty kilowatt or larger unit where the basic enclosure for the wind turbine is as big as an automobile.[7]

Wind power is sustainable and free. Wind resources are replenished with the heating and cooling of the earth.[8] The only "cost" in terms of

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1. Jim Marshall & Roscoe Bartlett, *Drilling for Clean Energy*, WASH. POST, Sept. 5, 2008, at A21; Frank G. Zarb, *How to Win the Energy War*, N.Y. TIMES, May 23, 2007, at A23.

2. Kristin Dispenza, *Cities Look Into Changing Zoning Laws to Accommodate Wind Power Generators,* GREEN BUILDING ELEMENTS, June 24, 2008, http://greenbuildingelements.com/2008/06/24/cities-look-into-changing-zoning-laws-to-accommodate-wind-power-generators; *see* Michael Donohue, *Siting of Wind Power Developments*, ZONING & PLAN. L. REP., Apr. 2005, at 1 (discussing the potential issues surrounding wind turbines such as harm to adjacent property).

3. S*ee generally* Ronald H. Rosenberg, *Diversifying America's Energy Future: The Future of Renewable Wind Power*, 26 VA. ENVTL. L.J. 505, 529 (2008) (discussing the costs of new energy technologies).

4. *See* NAT'L WIND COORDINATING COMM., WIND ENERGY SER. NO. 4, WIND ENERGY RESOURCES (1997), *available at* http://www.nationalwind.org/publications/wes/wes04.htm (discussing variability in wind pressure based on atmospheric conditions).

5. *Id.*

6. *Id.*

7. Rick Robinson, *Norman, Okla.-Based Wind Turbine Company Sees More Demand*, DAILY OKLAHOMAN, Dec. 1, 2001, at 32.

8. Melissa Hung, *Red Light, Green Light: With Billboards of Windmills Promising Gentle, Nonpolluting Energy, Green Mountain Offers Texans a New Power Avenue. Will They Take It? Should*

direct environmental impacts regarding the development of wind power systems is in the construction of the equipment and connection to the grid.[9]

The operation of wind power systems does have serious and presently unresolved environmental and aesthetic impacts. There is evidence that birds and bats are killed.[10] Newer design technologies seem capable of reducing these impacts, but the causes and complete remedies remain unclear.[11] There are also impacts on electromagnetic transmission of signals as well as complaints and concerns about adverse impacts on the reception of radio and television signals.[12] Visual impacts remain at the forefront of the debate.[13]

While much has been written on planning for and regulating large wind farm systems, there is a surprising lack of information about what local governments can and should do about the smallest of systems—the backyard wind turbine systems.[14] How do we plan for them? How should they be regulated? What should local officials and professional planners be doing to assist homeowners in making decisions about the installation of residential wind turbines?

First, we address basic background information on how the systems work. Next, we look at how homeowners decide whether their homesite is a good place for a small wind turbine and how to size and construct it. Then, we turn to the issues of planning and regulation, focusing ultimately on a model regulation for local residential wind power systems.

They?, HOUSTON PRESS, June 7, 2001, http://www.houstonpress.com/2001-06-07/news/red-light-green-light.

9. NAT'L WIND COORDINATING COMM., WIND ENERGY SER. NO. 2, WIND ENERGY ENVIRONMENTAL ISSUES (1997), *available at* http://www.nationalwind.org/publications/wes/wes02.htm.

10. U.S. GOV'T ACCOUNTABILITY OFFICE, GAO–05–096, WIND POWER: IMPACTS ON WILDLIFE AND GOVERNMENT RESPONSIBILITIES FOR REGULATING DEVELOPMENT AND PROTECTING WILDLIFE 1 (2005).

11. *Id*. at 2–3.

12. U.S. Dep't of Energy, New England Wind Forum: A Wind Powering America Project, http://www.windpoweringamerica.gov/ne_issues_interference.asp (last visited Mar. 8, 2009).

13. David Blittersdorf, *Making Energy Clean, Safe, and Affordable*, USA TODAY, Sept. 1, 2002, *available at* http://findarticles.com/p/articles/mi_m1272/is_2688_131/ai_91210320.

14. Rosenberg, *supra* note 3, at 537.

I. A PRIMER ON WIND TURBINES[15]

When the wind blows, the turbine turns and drives a generator, producing electricity.[16] All wind turbines require a minimum wind speed before they start producing electricity.[17] Typically, they begin to produce energy at wind speeds of nine to ten miles per hour (mph) and achieve their maximum rated power at twenty-five to thirty mph.[18] Turbines are designed to shut down when wind speeds exceed fifty-five to sixty mph to prevent them from being destroyed in the high winds.[19] This is commonly known as the cut-out speed. Shutdown at cut-out speed is done by altering the angle or pitch of the blades, extending spoilers on the blades that disrupt the airflow, or by applying an automatic brake.[20]

The most common form of the wind power turbine is horizontal with wind axis orientation.[21] Two or three blades are mounted on the front and they drive a generator via a horizontal shaft.[22] Some small wind energy systems use a vertical rotor.[23]

The front end of a horizontal wind turbine carries the rotor, which consists of blades similar to that of a helicopter or propeller-driven airplane.[24] The pitch varies from relatively steep near the center or root of the blade to a nearly flat pitch at the outer tip. This difference reflects the amount of lift or drive that varies with the speed of rotation at different distances from the center.[25] The portion of the blade closest to the axis moves slower through the air than the portion of the blade near the tip.[26]

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15. *See* WALTER HULSHORST, LEONARDO ENERGY, "HOW TO" MANUAL: SMALL SCALE WIND ENERGY SYSTEMS (2008), *available at* www.leonardo-energy.org/drupal/files/2008/How to Wind Energy.pdf?download (providing additional information on basic wind turbine construction and operation); *see also* MIKE COSTANTI ET AL., U.S. DEP'T OF ENERGY, WIND ENERGY GUIDE FOR COUNTY COMMISSIONERS (2006), *available at* http://www.nrel.gov/docs/fy07osti/40403.pdf (discussing ways that local county workers and planners can successfully implement commercial wind energy projects).

16. HULSHORST, *supra* note 15, at 6.

17. *Id.* at 4.

18. *Id.*; *see also* S. CLARKE, ONTARIO MINISTRY OF AGRIC., FOOD & RURAL AFFAIRS, ELECTRICITY GENERATION USING SMALL WIND TURBINES AT YOUR HOME OR FARM (2003), *available at* http://www.omafra.gov.on.ca/english/engineer/facts/03-047.htm (discussing minimum and optimal wind speeds).

19. HULSHORST, *supra* note 15, at 4.

20. *Id.* at 4–5.

21. *Id.* at 5.

22. *Id.*

23. *Id.*

24. *Id.*

25. Danish Wind Industry Association, Rotor Aerodynamics, http://www.windpower.org/en/tour/wtrb/rotor.htm (last visited Mar. 8, 2009).

26. *Id.*

Thus, in order to get the same lift or drive, the portion of the blade closest to the axis must be angled more steeply for even greater pitch than the portion of the blade near the tip.[27] The blade looks like it has a twist in it; that twist is the change in pitch.[28] The blades are typically made of metal, plastic, fiberglass, or some more esoteric composite.[29] The important dimension is the diameter or "swept area" of the blades.[30]

The horizontal shaft from the rotor either goes directly to the generator or, with larger wind turbine systems, through a gearbox in between to match the speed of the rotating blades to the generator's needs.[31] The generator is at the backend of the horizontal system and is sized to be driven by a rotor of a particular size and power.[32] The generator can produce alternating or direct current and can be sized to produce more or less power.[33] The principles of generator design remain unchanged from what you learned in high school physics—there are wire-wound elements that rotate within magnetic fields.[34]

Behind the generator there is a rudder or wind vane, like in a weathervane, to keep the rotor headed directly into the wind.[35] This tail vane can also be used in some systems at the cut-out speed to turn the wind turbine rotor away from the wind and reduce the speed of rotation.[36]

Encasing the shaft, gearbox, and generator is the nacelle (pronounced \nə-□sel\, from the French word for small boat). The nacelle is typically made of fiberglass, plastic, or light metal and is removable for maintenance and repair of equipment inside.[37]

Wind turbines need to be elevated well above any ground obstacles that will cause turbulence and above trees that block airflow.[38] They must be designed to operate in extreme winds and not to collapse from the wind force or the weight of ice.[39] They also must be properly designed and

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27. *Id.*
28. *Id.*
29. HULSHORST, *supra* note 15, at 6.
30. *Id.*
31. *See* Danish Wind Industry Association, *supra* note 25 (discussing large wind turbines); *see also* U.S. DEP'T OF ENERGY, SMALL WIND ELECTRIC SYSTEMS: A CONSUMER'S GUIDE 5 (2005), *available at* http://www.windpoweringamerica.gov/pdfs/small_wind/small_wind_guide.pdf (discussing small wind turbines).
32. HULSHORST, *supra* note 15, at 6.
33. *Id.* at 6.
34. Danish Wind Industry Association, *supra* note 25.
35. HULSHORST, *supra* note 15, at 6.
36. *Id.* at 7.
37. *Id.*
38. *Id.*
39. *Id.*

grounded to withstand lightning strikes. As noted, tower heights can vary greatly and there will be an incentive—offset by the additional cost—for increasing tower height because of the increased wind energy available.[40] An optimum height for a large wind turbine is 130 to 165 feet.[41] Backyard installations are unlikely to get to that height largely because of economics, but taller towers will be favored to some extent.

These towers can be of the self-supporting, monopole style or guy-wire-supported, latticed structures, which are the lower-cost alternative.[42] Guyed towers require more land area because the guy wires must be anchored away from the tower.[43] To make maintenance easier with smaller installations, such as those under five kilowatts, some towers may be designed to tilt down so that the wind turbine can be maintained and repaired from the ground, rather than from the top of the tower.[44]

Even residential wind turbine systems are not "plug-and-play." Electricity must be brought from the tower to the house with switches to initially disconnect it from the house.[45] If the house is off the grid, the power may need to be converted through an inverter to make it consistent with how the house is wired.[46] If the system is grid connected, an inverter converts the electricity so it is the same type as the electricity that is coming from the grid.[47] The systems typically include some means for measuring the amount of power produced.[48] In a grid-tied system, the house meter—specially designed for this type of installation—will run in reverse when the power generated from the wind turbine system exceeds the power consumed at the residence.[49]

II. PLANNING FOR RESIDENTIAL WIND POWER

If the system is grid tied, the process starts with assessing how much power is actually used on an annual basis. If it is going to be an off-the-grid system, the process of planning is somewhat more complicated

40. *Id.* at 7.
41. NAT'L WIND COORDINATING COMM., *supra* note 4.
42. HULSHORST, *supra* note 15, at 7.
43. *Id.*
44. *Id.*
45. U.S. DEP'T OF ENERGY, *supra* note 31, at 7.
46. *Id.*
47. *Id.*
48. MICK SAGRILLO, APPLES & ORANGES: CHOOSING A HOME-SIZED WIND GENERATOR 53 (2002).
49. *Id.* at 16.

because it must include sufficient storage capacity to carry the operation of home systems during times when there is little or no wind.[50]

The best way to determine how much energy is being used by an existing residence is to review consumption patterns over the last year or longer. Consumption information is usually readily available from the power company and can be used to determine an annual budget in kilowatt hours. At my second home in Vermont, which we use mostly on winter weekends, we consume about 3,500 to 4,000 kilowatt hours per year, whereas at my principal residence we use about 15,000 kilowatt hours per year. Sizing systems for the two houses would be profoundly different.

The next step is to determine whether the general wind pattern in the area will be adequate to drive a wind turbine to produce reasonable amounts of electric energy. There are many sources for maps. One place to start is the American Wind Energy Association (AWEA), which includes links to state-by-state information.[51] For example, the Department of Public Service in Vermont provides maps online that show average wind speeds throughout the year.[52] Sometimes, a better source of local information is a supplier of wind energy systems or someone who has installed and operated a system for some time because the scale of the publically available maps are frustratingly small and do not yield much useful information.[53] Local conditions—those on an individual lot—can be determinative. Consequently, in many instances it will be prudent to take wind measurements on a continual basis for several months to a year at or close to the elevation where the wind turbine will be placed. Local zoning approval, if it is required for a permanent wind turbine installation, will almost certainly have to be obtained for the temporary installation of monitoring equipment.[54] A mistake in determining wind speed, even a small error, will have a large effect on the wind power calculation because wind power is the cube of wind speed.[55] A ten percent difference in the

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50. *Id.* at 6, 19.

51. American Wind Energy Association, Small Wind in Vermont, http://www.awea.org/smallwind/vermont_sw.html (last visited Mar. 15, 2009) (providing information about Vermont winds).

52. Vermont Department of Public Service, Vermont's Wind Resource, http://publicservice.vermont.gov/energy/ee_files/wind/ee-wind.htm (last visited Mar. 15, 2009).

53. *See, e.g.*, New York State Energy Research and Development Authority, Wind Energy Toolkit, http://www.powernaturally.org/programs/wind/toolkit.asp (last visited Mar. 15, 2009) (discussing community resources for wind development in New York).

54. *See, e.g.*, MODEL AMEND. TO A ZONING ORD. OR BY-LAW: SMALL WIND ENERGY SYS. § 3.5 (Massachusetts Div. of Energy Res., Massachusetts Executive Office of Energy & Envtl. Affairs) (demonstrating a model zoning regulation regarding temporary wind installations).

55. PAUL GIPE, WIND ENERGY 145 (1995).

wind speed estimate will result in a thirty-three percent difference in wind power.

Because the wind is variable even over a small area, a public policy issue worthy of consideration is whether a wind energy study should be required as a condition precedent to approval of even a backyard wind turbine. Local governments may wish to consider establishing minimum annual average wind speeds for the installation of backyard wind turbine systems.[56]

In general, an important issue with wind power is that the wind blows without regard to peak electric needs and there are no practical storage systems for energy produced in excess of real time needs.[57] The wind often is strongest and more reliable away from population areas—for example, Kansas, Oklahoma, Texas, and the Rocky Mountains—and transmission is expensive and inefficient over long distances.[58]

One approach to overcoming this problem, to a limited extent, would be a state program for grid-tied, residential energy production that requires electric utilities to buy back the power that is in excess of current need. The Public Utilities Regulatory Policy Act (PURPA) requires utilities to pay the homeowner for any excess electricity produced up to the amount that the homeowner consumes.[59] The homeowner can draw down from the grid at times when needs at the house exceed the electricity being produced.[60] About forty states, including Vermont, have this program.[61] Vermont law does not require the electric utility to pay for excess electricity produced over a twelve month period, so the optimum strategy for homeowners is to develop systems that produce about what they use over a twelve month period.[62]

Electricity only begins to be generated when the turbine is turning at a minimum speed, but the electricity produced is not linear. The small

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56. *See generally* VERMONT ENVTL. RESEARCH ASSOCS., INC., ESTIMATING THE HYPOTHETICAL WIND POWER POTENTIAL ON PUBLIC LANDS IN VERMONT (2003) (discussing local government concerns).

57. *See* APS PANEL ON PUBLIC AFFAIRS COMM. ON ENERGY & ENV'T, CHALLENGES OF ELECTRICITY STORAGE TECHNOLOGIES (2007) (discussing wind energy storage concerns with current technology).

58. AM. WIND ENERGY ASS'N., ELECTRICITY TRANSMISSION FACT SHEET, http://www.awea.org/policy/documents/Transmission_Fact_Sheet.pdf (last visited Feb. 27, 2009).

59. Public Utility Regulatory Policies Act (PURPA) of 1978, 16 U.S.C. § 2621(d)(11) (2006).

60. *See* CLARKE, *supra* note 18 (discussing options for homeowners when they cannot generate all the power they need from their wind turbine).

61. Greg Pahl, *New and Improved Wind Power*, MOTHER EARTH NEWS, June/July 2007, *available at* http://www.motherearthnews.com/Renewable-Energy/2007-06-01/Improved-Wind-Power.aspx.

62. VT. STAT. ANN. tit. 30, § 219a(f)(3)(B)–(C) (2008).

residential system generally will not develop its rated power, say two kilowatts, until it reaches the rated wind power speed which is typically much faster than the average wind speed.[63] Maximum rated power, as noted above, is typically in the range of twenty-five to thirty-five miles per hour.[64] Burlington, Vermont, which enjoys relatively good wind, has never documented average monthly wind speeds that exceed ten miles per hour.[65]

The total cost of residential systems with a ten kilowatt wind turbine, a guyed tower of 80 to 100 feet, wiring, an inverter to convert the high-voltage electricity to standard power, and installation is likely to cost in the range of $50,000–$75,000, a significant portion of which may be offset by state grants and state and federal tax credits.[66] The payback for residential wind power installations in terms of savings in electricity costs offset by maintenance, capital reserve for replacement, and the carrying costs for such a system is anywhere from six to thirty years, or more.[67] The value of the system is likely to be capitalized in a somewhat higher home value.

Typical of the smaller systems, capable of producing more than fifty percent of a single family home's needs, is the 3.7 kilowatt Skystream system.[68] The Skystream 3.7 starts producing electricity at wind speeds of eight mph and reaches full output at twenty-nine mph.[69] The system is a direct drive with no gearbox and is downwind, meaning that the rotor is on the downwind side from the generator portion.[70] The rotor is twelve feet in diameter.[71] It can be installed on towers in the range of thirty-five to sixty-three feet and as tall as 110 feet.[72] The top of the tower should be a minimum of twenty feet above any surrounding object within 250 feet.

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63. *See* GIPE, *supra* note 55, at 145 (discussing that as a result of the cubic relationship between wind speed and power, a brief period of extremely high winds contributes to more total power than a steady period of high but not extremely high wind speed).

64. *See id.* at 157 (discussing that rated wind power ranges from twenty-two to thirty-six mph as a result of the lack of international consensus as well as tailoring wind turbines to different wind regimes and partly different approaches to maximizing total generation).

65. *See* National Climatic Data Center, Wind-Average Wind Speed (MPH), http://lwf.ncdc.noaa.gov/oa/climate/online/ccd/avgwind.html (last visited Mar. 15, 2009) (noting average wind speeds by major U.S. cities).

66. *See* Robert Levin, *Windmill Rules Are in the Works*, MOUNT DESERT ISLANDER, Oct. 2, 2008 (stating that the total cost of a mid-range system, six kilowatts, could exceed $60,000).

67. *See* Bergey Wind Power Co., Frequently Asked Questions, http://www.bergey.com/School/FAQ.Residential.html (last visited Mar. 15, 2009) (discussing the payback for residential wind systems which depends largely on the average wind speeds and the cost of electricity in the respective locality).

68. Southwest Windpower, Inc., Skystream at 3.7, http://www.skystreamenergy.com/documents/datasheets/skystrea_%203.7t_datasheet.pdf.

69. *Id.* at 1.

70. *Id.* at 2.

71. *Id.*

72. *Id.* at 3.

Generally, properties of one acre or more will be desirable because they are likely to have unobstructed wind flow.[73] The manufacturer says that ideal sites will have an average wind of twelve mph or greater.[74] It also claims that the noise is "unrecognizable over trees blowing in the wind" and states that noise in the range of forty to fifty decibels is "quieter than background noise in a home or office."[75] The installed costs are estimated at $12,000–$18,000 with possible payback coming as quickly as five years (assuming electricity rates of $0.10 or greater per kilowatt hour).[76]

III. Issues for Local Planning[77]

A. State Enabling Authority

All local land use regulatory power comes from the state.[78] A first step in developing a local-backyard-wind power regulatory program is to review the state enabling legislation and municipal charter, if there is one, to determine what local regulatory power has been enabled under state law.[79] Most municipalities in most states have several avenues open to them to adopt small wind turbine regulation. It is most directly and conveniently done through a zoning ordinance, but in some states it is possible where there is no zoning, to do it under subdivision regulation.[80] It might also be accomplished through a strict police power regulation, which is outside of both zoning and subdivision regulation.

California has largely preempted regulatory standards for small wind turbines through the adoption of Assembly Bill 1207 in 2001.[81] The law

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73. *Id.*

74. *Id.*

75. *Id.* at 2.

76. *Id.* at 2–3.

77. *See generally* Clifford C. Rohde, *There's ~~Gold~~ Wind in Them Thar Hills. But How Do You Zone It?* TALK OF THE TOWNS, Sept./Oct. 2008, at 6–7, *available at* http://windpowerlaw.files.wordpress.com/2008/10/nystownsmagazine200809-10.pdf (discussing local issues within New York regarding wind energy planning).

78. *See generally* Glebe Mountain Wind Energy, LLC, No. 234-11-05 Vtec, (Vt. Envtl. Ct. Aug. 3, 2006) (discussing the jurisdictional conflict between a state statute and local planning).

79. *See generally* Roberts v. Manitowoc County Bd. of Adjustment, 721 N.W.2d 499, 504 (Wis. Ct. App. 2006) (holding that the Board competently interpreted the state statute regarding wind power).

80. Mark K. Dausch, *Analyzing a Municipality's Authority to Enact the Model Ordinance for Wind Energy Facilities in Pennsylvania*, 45 DUQ. L. REV. 47, 47–48 (2006) (discussing the Model Wind Ordinance which gives guidance to local governments in regulating wind farms).

81. Assem. B. No. 1207 Reg. Sess. (Cal. 2001); *see* PETER ASMUS ET AL., PERMITTING SMALL WIND TURBINES: A HANDBOOK (2003), *available at*

becomes the default permitting ordinance in California counties that do not regulate small wind turbine systems.[82] In counties where there are regulations, the state statute sets standards for local regulation of tower height, notification, setbacks, noise level, approval processes, submission requirements, and technical review. Under the statute, counties are not permitted to impose more restrictive standards.[83]

B. Wind Assessment

Because existing data is generally inadequate and performance of wind turbines varies greatly from site to site (as a result of small area factors specific to the property), local planners may wish to undertake a more detailed analysis of wind patterns in the community and map them with regulations.[84] This ultimately encourages development of wind energy systems in the high production areas and discourages, or even prohibits, them in areas where the wind is insufficient.[85] Average or mean wind speeds can be deceiving when the distribution of the times of wind speed is not normal. Wind speed analysis should include ranges of wind speed, the hours per year of wind speed in each range, the output during those hours, and the total output in kilowatt hours per year for each of those ranges.[86] It is only through this analysis that a reasonable determination can be made as to what the actual production will be. It may be prudent to require a wind energy study for a year or more before permitting the installation.

C. Visual impacts

Larger, taller installations have the greatest visual impact, particularly along high wind energy areas such as ridge tops. Planners may wish to undertake a visual analysis of their communities to determine where wind turbines would be visually acceptable and unacceptable at identified elevations. Some towers may require aircraft warning lights, which may make them entirely unacceptable in residential areas. Local plans should

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http://www.awea.org/smallwind/documents/permitting.pdf (providing more on the California experience and small system planning and regulation).

82. Assem. B. No. 1207, *supra* note 81; ASMUS ET AL., *supra* note 81, at 21–22.

83. Assem. B. No. 1207, *supra* note 81; ASMUS ET AL., *supra* note 81, at 21.

84. *See* KENNETH H. YOUNG, ANDERSON'S AMERICAN LAW OF ZONING § 9:48A (4th ed. Supp. 2008) (providing an overview of local planning and regulation for wind power).

85. *Id.*

86. *See generally* PAUL GIPE, WIND ENERGY COMES OF AGE 145–51 (1995) (discussing how the speed of wind affects total power output).

identify the areas of the community and the elevations at which aircraft warning lights are required under federal law.

Tower height in absolute terms is always a consideration. Bar Harbor, Maine is considering a draft ordinance that will allow towers less than sixty feet high after code enforcement officer approval alone but will require review and approval by the planning board for taller towers.[87] Discussion before the planning board on the draft ordinance has included whether to notify neighbors when a tower is going to be forty feet tall or higher and what is an acceptable setback requirement.[88] As to the latter, the board appears ready to require a setback equal to the height of the tower, which would allow wind turbines on lots as small as one acre.[89]

A New York court recently addressed the question of whether setbacks for wind turbine towers constitute a de facto taking.[90] The action was brought by a neighborhood group opposing a wind turbine generator project.[91] The court rejected the claim that the setback requirements caused a de facto taking.[92] The court reasoned that the imposition of setbacks from residences, public roads, and properties that do not contain turbines were within the proper exercise of governmental powers and did not encroach upon private property owned by those who do not consent to having turbines on their property.[93]

With certain installations and light angles there can be a shadow flicker which is visually disturbing. Wind turbines have shadows; in morning and late afternoon hours it is not unusual to have shadows cast across a window or yard.[94] When the blades are turning, there is a flicker to the shadow which can be quite disturbing.[95] It does not happen often, or for long periods, but for nearby properties it can be an annoyance.[96]

The potential for flicker can be evaluated. Local standards should be established for the number of hours per year and the number of minutes per day when flicker can affect neighboring properties. There are no generally

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87. Robert Levin, *Windmill Ordinance is Introduced*, MOUNT DESERT ISLANDER, Oct. 24, 2008, at 1, *available at* http://mdislander.com/site/index.php?option+com_content&task=view&id+7729&Itemid=36.

88. *Id.*

89. *Id.*

90. Advocates for Prattsburgh, Inc. v Steuben County Indus. Dev. Agency, 48 A.D.3d 1157, 1158 (N.Y. App. Div. 2008).

91. *Id.*

92. *Id.*

93. *Id.*

94. EDEN PROJECT WIND TURBINE, ENVIRONMENTAL REPORT § 6.1.1 (2008), *available at* http://www.edenproject.com/documents/Shadowflicker.pdf.

95. *Id.* at §§ 6.1.1–6.1.3.

96. *Id.*

acceptable standards. One source speculates that the radius for impact analysis should be about 1,750 feet around the tower and that flicker should not exceed thirty hours per year and a maximum of thirty minutes per day.[97] The potential for flicker is very low once you get beyond ten rotor diameters from the turbine, so it is unlikely to be a serious problem with the small rotors in typical homeowner installations.[98]

It may be difficult for opponents of backyard wind turbines to challenge them on aesthetic grounds. Recently, a Texas appeals court upheld a trial court's dismissal of public and private nuisance claims regarding the construction and operation of a wind farm.[99] The court found that the nuisance claim was based solely on the emotional response of the neighbors to their loss of view in the presence of numerous 400-foot-tall wind turbines.[100] The court would not minimize the impact of the wind farm:

> Unobstructed sunsets, panoramic landscapes, and starlit skies have inspired countless artists and authors and have brought great pleasure to those fortunate enough to live in scenic rural settings. The loss of this view has undoubtedly impacted Plaintiffs. A landowner's view, however, is largely defined by what his neighbors are utilizing their property for. Texas case law recognizes few restrictions on the lawful use of property. If Plaintiffs have the right to bring a nuisance action, because a neighbor's lawful activity substantially interferes with their view, they have, in effect, the right to zone the surrounding property. Conversely, we realize that Plaintiffs produced evidence that the wind farm will harm neighboring property values and that it has restricted the uses they can make of their property area. FPL's development, therefore, could be characterized as a condemnation without the obligation to pay damages.[101]

In the end, however, the court held that under Texas law aesthetics alone cannot be the basis for a nuisance action.[102]

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97. HULSHORST, *supra* note 15, at 15.

98. *See* EDEN PROJECT, *supra* note 94, at § 6.1.1 (noting that shadow flicker generally does not create a disturbance in the open since light outdoors is reflected from all directions).

99. Rankin v. F.P.L. Energy, L.L.C., 266 S.W.3d 506, 506 (Tex. Ct. App. 2008).

100. *Id.*

101. *Id.* at 512.

102. *Id.*

D. Environmental Impacts

The principal environmental impacts are bird and bat kills.[103] Nothing in the literature suggests that this is a serious problem for small, backyard systems, but it is prudent for local government in preparing wind energy overlay maps to identify nesting areas, flyways, and other locations of higher bird and bat populations. Some areas may not be suitable for any wind power development.[104]

E. Wake Effect

A wake is the disturbance of a fluid when something passes through it, such as the wake behind a boat or the wake from an airplane.[105] The rotors of a wind turbine cause a wake and that disturbance of airflow adversely affects the operation of turbines downwind.[106] Obviously, this only occurs with an impact on downwind users when the wind is coming from a certain direction. Also, the disturbance is generally limited to about ten times the turbine blade length.[107] Wake effect is unlikely to be a problem with small wind turbine systems on residential lots; thus, regulation is probably not required.

F. Noise

There are two types of noise from wind turbines. Aerodynamic noise is caused by the blades.[108] Mechanical noise is caused by the equipment itself: the shaft turning against bearings, gears, the generator, and even vibrations in the nacelle.[109]

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103. John Ritter, *Wind Turbines Taking Toll on Birds of Prey*, USA TODAY, Jan. 4, 2005, http://www.usatoday.com/news/nation/2005-01-04-windmills-usat_x.htm; Fort Collins Science Center, U.S. Geological Society, Bat Fatalities at Wind Turbines: Investigating the Causes and Consequences, http://www.fort.usgs.gov/BatsWindmills (last visited Mar. 18, 2009).

104. *See* Gregory M. Adams, *Bringing Green Power to the Public Lands: The Bureau of Land Management's Authority and Discretion to Regulate Wind-Energy Developments*, 21 J. ENVTL. L. & LITIG. 445, 453–58 (2006) (noting that in certain areas wind farms create a high risk for wildlife degradation).

105. MERRIAM-WEBSTER'S COLLEGIATE DICTIONARY 1406 (11th ed. 2007).

106. Plaintiff's Response to Defendants' OGLE County Board of Commissioners et al. Rule 12(b)(1) Motion to Dismiss, Muscarello v. Olge Country Bd. of Comm'rs, No. 3:06CV50017, 2007 WL 5021065, at *5 (N.D. Ill. May 3, 2007).

107. *Id.*

108. American Wind Energy Association., Facts about Energy and Noise, http://www.awea.org/pubs/factsheets/WE_Noise.pdf.

109. *Id.*

Aerodynamic noise tends to be more "natural" sounding, like wind passing through the trees.[110] It can be highly distracting, however, because a wind turbine takes on a rhythmic beat that speeds up and slows down. Mechanical noise tends to be more tonal in nature. An advocate of wind power systems describes the noise: "You may hear a whisper, a hair of light noise."[111] In preparation for permitting backyard wind turbines, a municipality should review its noise ordinance, if it has one, and the municipality should also consider adopting one, if necessary, taking into account the particular type of noise generated by wind turbines.

A fifty-five decibel noise standard is discussed at length in one recent wind farm case.[112] The problem with noise is that it is highly subjective and directly related to distance.[113]

G. Safety

The three principal safety issues for backyard wind turbines are: (1) catastrophic failure of the tower; (2) piecemeal failure of the rotor, nacelle, and other equipment with parts becoming airborne; and (3) ice being flung from the blades or coming off of the structural elements.[114] It is no more necessary to fence off the wind tower than it is for any other tower, such as those for amateur radio or television reception. However, some consideration should be given to investigating the safety record of those installing towers and equipment and for mandating periodic maintenance and inspection, with reports to local authorities.

H. Electrical Interference

Electrical interference can be an issue in some cases because the generator produces electromagnetic radiation. A faulty generator in an

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110. *Id.*

111. Levin, *supra* note 66.

112. Rankin v. F.P.L. Energy, L.L.C., 266 S.W.3d 506, 514 (Tex. Ct. App. 2008).

113. ERNEST V. F. HODGSON, CONTEMPORARY PROBLEMS IN APPROPRIATE TECHNOLOGY: RESIDENTIAL WIND TURBINES AND NOISE EMISSIONS 8–9 (2004), *available at* http://www.wind.appstate.edu/reports/ResidentialWindTurbinesandNoiseEmissions.pdf.

114. CANADIAN WIND ENERGY ASS'N, CANADIAN WIND ENERGY ASSOCIATION POSITION ON SETBACKS FOR LARGE-SCALE WIND TURBINES IN RURAL AREAS (MOE CLASS 3) IN ONTARIO 9, 11 (2007), *available at* http://www.canwea.ca/images/uploads/File/FINAL-CanWEAPositionOnSetbacks-2007-09-28.pdf; *see* HODGSON *supra* note 113, at 5 (discussing setbacks, even though it is of limited relevance, because it solely addresses large-scale wind turbines).

automobile, for example, can cause static in the radio.[115] Most problems of unwanted electromagnetic radiation can be solved with filters.[116] It may be prudent to require that the immediate neighbors of a proposed small wind turbine provide some baseline as to the operation of their radio and television receivers and other electronic installations subject to interference by electromagnetic radiation. In this way, if there is claimed disturbance after the installation, the question of cause and effect may be addressed. The source of interference is readily isolated by shutting down the wind turbine.

Electrical interference can also include the impact of rotating blades and support structures, principally on amplitude modulated (AM) radio.[117] The physical location of towers, turbines, and rotating blades can cause interference with conventional and Doppler radar.[118] Because radar is line of sight, a wind turbine in the path of the radar can interrupt or scatter the signal.[119] The following are the types of systems that might be impacted by small wind turbines: cable distribution off-air receiver systems; satellite uplinks and receiver systems; direct to home receiver systems; radar (weather, defense, and air traffic); airport communications and guidance systems; broadcasting—AM, FM, and TV; Coast Guard communications and vessel traffic radar systems; point-to-point radio communication links; point-to-multipoint systems; cellular type networks; and seismological and infrasound monitoring systems.[120]

115. William C. Anderson, *Adios, Snap, Crackle, Pop: Eliminating Radio Interference*, OLD CARS WEEKLY, http://www.oldcarsweekly.com/article/Adios_snap_crackle_pop_Eliminating_radio_interference (last visited Mar. 15, 2009).

116. *See* Shanghai UOU New Energy Company, Frequently Asked Questions, http://www.u-energy.biz/About.asp?p=FAQ (last visited Mar. 15, 2009) (discussing deflectors and repeaters as methods to quell electromagnetic radiation).

117. RADIO ADVISORY BD. OF CAN. & CANADIAN WIND ENERGY ASS'N, TECHNICAL INFORMATION AND GUIDELINES ON THE ASSESSMENT OF THE POTENTIAL IMPACT OF WIND TURBINES ON RADIO COMMUNICATION, RADAR AND SEISMOACOUSTIC SYSTEMS 5 (Apr. 2007), *available at* http://www.rabc-cccr.ca/Files/RABC%20CANWEA%20Wind%20Turbine%20Guidelines%20Final_ok-RABC%20CANWEA%20Wind%20Turbine%20Guidelines%20Final_ok1.pdf.

118. *Id.*

119. *Id.*

120. *Id.*

IV. A Model Local Ordinance[121]

Taking what is available in the literature and melding it with some of the good advice others have offered yields the outlines of a model

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121. S*ee* Genesee/Finger Lakes Regional Planning Council, Wind Energy Local Government Support, http://www.gflrpc.org/programareas/wind/resources.htm (last visited Jan. 17, 2009) (providing links to many different local wind zoning ordinances); *see also* MODEL AMEND. TO A ZONING ORD. OR BY-LAW: SMALL WIND ENERGY SYS. § 3.5 (Massachusetts Div. of Energy Res., Massachusetts Executive Office of Energy & Envtl. Affairs) (offering a model by-law for small cities and towns in establishing reasonable standards for small wind power development); KATHERINE DANIELS, N.Y. ST. ENERGY RES. & DEV. AUTHORITY, WIND ENERGY MODEL ORDINANCE OPTIONS (2005), *available at* http://www.powernaturally.org/programs/wind/toolkit/2_windenergymodel.pdf (discussing options for creating a local wind energy ordinance); N.Y. ST. ENERGY RES. & DEV. AUTHORITY, EXAMPLES OF NY LOCAL GOVERNMENT LAWS/ZONING PROVISIONS ON WIND (2005), *available at* http://www.powernaturally.org/programs/wind/toolkit/3_revised.pdf (exploring New York local government model ordinances); Shelly, Idaho, tit. 10-21-2 (2009), *available at* http://www.ci.shelley.id.us/vertical/Sites/%7BC6ED73CC-2B19-4571-98FA-5B8002C36DF2%7D/uploads/%7B025BE757-0980-4AD4-8C48-9B7289ED8E84%7D.PDF.; *See, e.g.*, Notice of Public Hearing § 108-31(B)(2), http://www.riverheadli.com/05.12.08.wind.energy.pdf (noting the similarities between the two proposals); *See, e.g.*, MITCHELL, WIS., WIND ENERGY FACILITY ORDINANCE § 5.1(5), http://www.townofmitchell.com/ordinances/windturbines.pdf (discussing placement of wiring); *See, e.g.*, HOLDERNESS, N.H., RESIDENTIAL SMALL WIND ENERGY SYSTEM REGULATION § 4, http://www.holderness-nh.gov/Public_Documents/HoldernessNH_Ordinances/site_review/APPENDIX_6.pdf (providing the same automatic over-speed controls); *See, e.g.*, NEW YORK STATE ENERGY RESEARCH AND DEVELOPMENT AUTHORITY, WIND ENERGY MODEL ORDINANCE OPTIONS, http://www.powernaturally.org/programs/wind/toolkit/2_windenergymodel.pdf (last visited Mar. 18, 2009) (discussing interference avoidance for wind turbines); *See, e.g.*, ERNEST V. F. HODGSON, RESIDENTIAL WIND TURBINES AND NOISE EMISSIONS 14, http://www.wind.appstate.edu/reports/ResidentialWindTurbinesandNoiseEmissions.pdf (discussing similar noise levels in Oregon); *See, e.g.*, Notice of Public Hearing § 108-31(C), http://www.riverheadli.com/05.12.08.wind.energy.pdf (stating from where the measurement of the noise is taken); *See, e.g.*, 310 MASS. CODE REGS. 7.10 (West 2008) (discussing appropriate ambient noise levels in Massachusetts); LARRY KROM ET AL., FOCUS ON ENERGY PROGRAM, SMALL WIND ENERGY SYSTEM ORDINANCE 4 (2006) *available at* http://www.renewwisconsin.org/wind/Toolbox-Zoning/Small%20Wind%20System%20Model%20Ordinance%2012-06.pdf; MODEL SMALL WIND ENERGY SYSTEM ORDINANCE, SOUTHWEST MICHIGAN PLANNING COMMISSION *available at* http://www.swmpc.org/downloads/The%20Small%20Wind%20Energy%20Ordinance.pdf; *See* CURRITUCK COUNTY, RESIDENTIAL WIND TURBINE APPLICATION PACKET, (2008), *available at* http://www.co.currituck.nc.us/pdf/form-inspections/Wind-Turbine-Application-2008.pdf (providing a comprehensive discussion of the application procedures implemented in Currituck County, North Carolina); *See* GRAND COUNTY, WIND TURBINES *available at* http://www.skyhidailynews.com/assets/pdf/GC58906117.PDF (providing a draft regulation regarding approval and code compliance for residential wind turbines in Grand County, Colorado); AM. WIND ENERGY ASS'N, SMALL WIND FACTSHEETS 2 (2003), http://www.awea.org/smallwind/toolbox/improve/model_zoning.pdf; *See* MASS. DIVISION OF ENERGY RES., MASS. EXECUTIVE OFFICE OF ENERGY & ENVTL. AFFAIRS, MODEL AMENDMENT TO A ZONING ORDINANCE OR BY-LAW: SMALL WIND ENERGY SYSTEMS 5, http://www.mass.gov/Eoca/docs/doer/renew/model-allow-wind-small.pdf (last visited Mar. 17, 2009); *See* AM. WIND ENERGY ASS'N, IN THE PUBLIC INTEREST: HOW AND WHY TO PERMIT FOR SMALL WIND SYSTEMS 13 (2008), http://www.awea.org/SMALLWIND/pdf/InThePublicInterest.pdf.

ordinance. Be advised—any model has to be reworked for local conditions, including politics. A cut-and-paste approach to ordinance writing is dangerous.[122]

SMALL WIND TURBINES

Intent

To provide for the development of clean, renewable energy resources while protecting the public health, safety, and welfare of the community, the [city/state] finds these regulations are necessary to ensure that small wind turbines are appropriately designed and safely sited and installed.

This ordinance establishes the regulations and criteria which allow small wind turbines as compatible accessory uses in residential districts. Unless otherwise provided, all accessory uses are subject to the same regulations as the principal use located on the lot.

Definitions

Small Wind Turbine: A wind energy conversion system consisting of a wind turbine, tower, and associated control or conversion electronics, which has a rated capacity of not more than ten kilowatts and is intended to primarily reduce on-site consumption of utility power. A system is considered a residential small wind turbine only if it supplies electrical power solely for on site use, except that when a parcel on which the system is installed also receives electrical power supplied by a utility company, excess electrical power generated and not presently needed for on site use may be used by the utility company. A small wind turbine includes a temporary meteorological tower erected for up to three years.

Tower: The vertical component of a wind energy conversion system that elevates the wind turbine generator and attached blades above the ground.

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122. Years ago (the name of the town is long lost from memory) a New Hampshire community adopted its first flood damage prevention regulation, as required to qualify for the National Flood Insurance Program. They followed the national model regulation as there were no state models yet written. For a while, one small New Hampshire town, because it adopted the model without careful review, had obligated itself to protect its mangrove swamps.

Regulations

Small wind turbines are a permitted accessory use in all residential zoning districts subject to the following:

Number of small wind turbines: One per residential unit.

Tower height: For lots smaller than one-half acre in area, small wind turbines shall be roof mounted and can not be higher than forty-five feet above the ground to the highest point of the rotor or blade as measured by [cite regulation for residential building height]. The maximum rotor diameter for small wind turbines shall be six feet.[123]

For lots between one-half acre and one acre, the tower height shall be limited to one hundred feet, or twenty feet above the tree line, whichever is lower.

For lots greater than one acre or more, the tower height shall be limited to 120 feet or forty feet above tree line, whichever is lower.

Lighting: No tower is permitted that requires any lighting under federal, state, or local law.

Blade clearance: There shall be a minimum of thirty feet between the ground and the lowest point of the rotor blade. No blades may extend over parking areas, driveways, or sidewalks.

Security: Unauthorized access to the tower shall be prevented by design, with a minimum of twelve feet from the ground to the bottom of the ladder. All doors to small wind turbine towers and electrical equipment shall be locked.

Set-back: No part of the small wind turbine structure, including guy wire anchors, may extend within ten feet of the property boundaries of the installation site. Small wind turbines shall be set back a distance equal to the total height of the wind turbine from all inhabited structures off-site, overhead utility lines, and public roads or rights-of-way.

Wiring underground: All wiring from the tower to the residence shall be underground.

Automatic over-speed controls: All small wind turbines shall be equipped with manual—electronic or mechanical—and automatic over-speed controls to limit the blade rotation speed to within the design limits of the residential wind energy system.

Interference avoidance: Small wind turbines shall not be installed in any location where their proximity would interfere with existing fixed broadcast, retransmission, or reception antenna. This includes interference

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123. This is an arbitrary number and could be adjusted up or down, or it could be made more flexible with a larger rotor authorized by special permit when stated criteria are met.

with residential radio, television, or wireless phone, or other personal communication system reception. No small wind turbines shall be installed in any location along the major axis of an existing microwave communication link where its operation is likely to produce electromagnetic interference in the link's operation.

Noise: Noise from small wind turbines shall not exceed fifty decibels, or ten decibels above ambient noise in any one hour, whichever is higher. Noise is measured from the closest neighboring inhabited dwelling or nearest habitable dwelling setback on abutting property, whichever is closer. The ambient sound measurement, known as "A-weighted sound level" is taken where the noise from the small wind turbine cannot be heard, or with the small wind turbine shut down. The ambient sound level is rarely found to be constant over time, and is usually quite variable. The ambient sound level is considered to be the level that is exceeded ninety percent of the time when the noise measurements are taken. The fifty decibel or ten decibel level may be exceeded during short-term events such as utility outages and severe wind storms.

Appearance: The small wind turbine and tower shall have a flat finish as applied by the manufacturer. The objective is to have the equipment as inconspicuous as practicable.

Information to be submitted: All applications shall include the information required for a site plan approval pursuant to section [cite site plan submission requirements]. In addition, the applicant shall submit:

(a) A plot plan showing:

(i) Property lines and physical dimensions of the subject property within two times the total height from the tower location;

(ii) Location, dimensions, and types of existing major structures on the property;

(iii) Location of the proposed wind system tower, foundations, guy anchors, and associated equipment;

(iv) The right-of-way of any public road that is contiguous with the property; and

(v) Any overhead utility lines;

(b) Small wind turbine system specifications, including manufacturer and model, rotor diameter, tower height, and tower type—freestanding or guyed;

(c) Tower foundation blueprints or drawings signed by a professional engineer licensed to practice in the state of [state].

(d) Tower blueprint or drawing signed by a professional engineer licensed to practice in the state of [state].

(e) A statement of how much electricity is expected to be consumed at the property, how much is planned to be provided by the small wind turbine, and what analysis has been done to establish that the expectations of the project can be met. It is suggested that a temporary metrological tower be installed and the performance monitored for one year before undertaking a permanent installation, particularly of a larger and more expensive system.[124]

Notice to neighbors: Two weeks prior to submitting any application for approval of a small wind turbine, the applicant shall send a letter providing notice of the proposal, with a certificate of mailing, to all abutting neighbors and any neighbor whose house is within 500 feet of the proposed small wind turbine location. It is recommended that the applicant meet with municipal staff before preparing the application and that the applicant meet in person with the neighbors to explain the proposal.

Approved wind turbines: Residential small wind turbines must be approved under an Emerging Technology program such as the California Energy Commission, International Electotechnical Commission, or any other small wind certification program recognized by the American Wind Energy Association (AWEA) or the U.S. Department of Energy. Non-certified residential wind turbines must submit a description of the safety features of the turbine prepared by a registered mechanical engineer.

Compliance with Uniform Building Code [or other applicable code]: Building permit applications for small wind turbines shall be accompanied by standard drawings of the wind turbine structure, including the tower, base, and footings. An engineering analysis of the tower showing compliance with the Uniform Building Code and certified by a licensed professional engineer shall also be submitted. This analysis is frequently supplied by the manufacturer.

Compliance with Federal Aviation Adminstration (FAA) Regulations: Small wind turbines must comply with applicable FAA regulations, including any necessary approvals for installations close to airports.

Compliance with National Electric Code: Building permit applications for small wind turbines shall be accompanied by a line drawing of the electrical components in sufficient detail to allow for a determination that the manner of the installation conforms to the National Electrical Code. This information is frequently supplied by the manufacturer.

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124. S*ee* CURRITUCK COUNTY, RESIDENTIAL WIND TURBINE APPLICATION PACKET (2008) *available at* http://www.co.currituck.nc.us/pdf/form-inspections/Wind-Turbine-Application-2008.pdf (providing a comprehensive discussion on the application procedures implemented in Currituck County, North Carolina).

Utility Notification: No small wind turbine shall be installed until evidence has been given that the utility company has been informed of the customer's intent to install an interconnected customer-owned generator. Off-grid systems shall be exempt from this requirement.

Maintenance: The applicant shall maintain the small wind turbine and related equipment in good condition, and shall provide a written report of inspection and maintenance every two years to the building official who will provide a form for the report. The report shall be signed by the original installer of the system or someone of equivalent qualifications.

Insurance: Prior to the issuance of a building permit for the installation of a small wind turbine, the applicant shall provide the building official with evidence that the homeowner's insurance policy has been endorsed to cover damage or injury that might result from the installation and operation of the small wind turbine system.

Removal: If a small wind turbine becomes inoperable and is not put back into service within six months, the applicant shall remove the small wind turbine, tower, and other related equipment.

CONCLUSION

Small wind turbines raise many of the same issues as midsize wind energy conversion systems and wind farms. However, with their small size and their use accessory to a residence, they are more readily accepted than their larger counterparts. The objective in planning for and regulating small wind turbines is to assist the individual homeowner in making sure the project makes economic sense from the outset. It is important also to protect the property owner and neighbors from the potential hazards of a tall structure in a residential setting.

The regulations should be kept simple. The model suggested here has an emphasis on getting the applicant to reach out to his or her neighbors to talk about the project before formal submission. There is no suggestion in this model as to the degree of discretionary approval. Should it be reviewed and approved as an as-of-right use through the building official alone, or should it be subject to a more formalized site plan review in a public meeting, or should there be an even more discretionary review under the special permit process with a full hearing? In the case of small residential systems, it may be best to err on the side of as-of-right regulation, subject only to fair notice to the neighbors before the project goes forward.

Regardless, with the increased concerns about sustainability, the uncertain cost of fossil fuels, and the availability of federal and state incentives for the installation of renewable energy systems, we are certain to see more small wind turbines in backyards. With good local planning and local regulations that are simple and fair, it may be possible to have the orderly development of this important and diverse energy system for the benefit of the homeowner who takes the initiative to install a small wind turbine and for the benefit of society generally.