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# CONVERTING BROWNFIELD ENVIRONMENTAL NEGATIVES INTO ENERGY POSITIVES

Steven Ferrey*

**Abstract**: There is a new paradigm for evaluating landfills. While landfills are contaminated repositories of hazardous wastes, they also are brownfields that can be redeveloped for renewable energy development. It is possible to view landfills through a new lens: As endowed areas of renewable energy potential that can be magnets for a host of renewable development incentives. Landfills also are critical resource areas for the control of greenhouse gases. Landfill materials decompose into methane, a greenhouse gas that is more than twenty times more potent—molecule for molecule—than carbon dioxide. This Article traces the molecular composition of waste in landfills, analyzing the chemical stew that brews in these repositories. Without doubt, landfills in America are brownfields. And many of these landfills leak and cause public health risks. This Article also analyzes the potential to utilize landfill gas for electricity production or as a thermal resource. It evaluates the energy potential at municipal sewage treatment plants and the ability to utilize the land at landfills to host wind turbines. The environmental regulatory envelope that surrounds landfill operation is explored. Also analyzed are the various incentives that foster renewable energy development and are applicable to landfill brownfields development. These include tax credits, tax-preferenced financing, renewable energy credits under state renewable portfolio standard (RPS) systems in twenty-two states, and direct renewable trust fund subsidies in sixteen states, as well as net metering available in forty states. Finally, creative techniques to mitigate derivative environmental liability under Superfund, the Resource Conservation and Recovery Act (RCRA), and similar state laws that can accompany energy operations at a landfill, are suggested.

## Introduction: From Environmental Negatives to Energy Positives

When discussing greenhouse gases, landfills are critical for several reasons. First, they constitute a large share of U.S. greenhouse gas emis-

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sions: as of 2000, the United States is responsible for approximately eleven percent of worldwide methane emissions.[1] Approximately thirty percent of U.S. anthropogenic methane emissions, which is equivalent to 193.6 million metric tons, came from waste management in 2003.[2] Landfills represent ninety-two percent of the 193.6 million metric tons of methane emissions, by far the single largest source.[3] Approximately 5.2 million metric tons of the 178.1 million tons of landfill methane annually are captured as landfill gas (LFG); 2.6 million metric tons of this is used for productive energy, while 2.6 million metric tons of the recovered LFG are flared with no productive energy capture.[4]

Second, the feedstock of LFG—municipal solid waste (MSW)—is the only increasing renewable resource. Total generation of MSW in the United States has increased more than fifty percent since 1980 to a level of 236.2 million tons annually.[5] The per capita MSW generation rate is 4.45 pounds per person per day.[6] This increase is not necessarily a positive attribute, but it is reality. MSW generation rates in European countries are significantly lower.[7]

Third, landfills are the repository for the bulk of MSW. Approximately fifty-six percent of U.S. MSW goes to landfills as its final destination.[8] Thirty years ago, in 1978, there were 20,000 operating landfills in

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[1] *See* U.S. Envtl. Prot. Agency, EPA 430-R-06-003, Global Anthropogenic Non-$CO_2$ Greenhouse Gas Emissions: 1990-2020 app. A-2 (2006). The Environmental Protection Agency (EPA) estimates that in 2000, global levels of methane emissions reached approximately 6020.16 million metric tons of carbon dioxide equivalent (MtCO2eq), while the United States emitted roughly 546.42 MtCO2eq. *Id.*

[2] Office of Integrated Analysis & Forecasting, Energy Info. Admin., DOE/EIA-0573, Emissions of Greenhouse Gases in the United States 2004, at xv tbl.ES4 (2005), *available at* http://www.eia.doe.gov/oiaf/1605/gg05rpt/pdf/057304.pdf [hereinafter Emissions of Greenhouse Gases]. This value has been decreasing because of a robust effort to capture methane for productive purposes or destruction. *See id.* at 13, 36. Landfills constitute the single largest source of methane emissions within the United States, responsible for approximately one-third of human-related methane emissions, while human-related activities such as natural gas and petroleum systems, livestock and wastewater treatment, and landfills account for sixty percent of all emissions. U.S. Environmental Protection Agency, Methane: Sources and Emissions, http://www.epa.gov/outreach/sources.html (Oct. 19, 2006).

[3] *See* Emissions of Greenhouse Gases, *supra* note 2, at xv tbl.ES4. The remaining eight percent of these emissions from waste management are associated with domestic wastewater treatment programs. *See id.*

[4] *See id.* at 50.

[5] *See* U.S. Envtl. Prot. Agency, Municipal Solid Waste Generation, Recycling, and Disposal in the United States: Facts and Figures for 2003, at 2 tbl.1 (2003), http://www.epa.gov/msw/pubs/msw03rpt.pdf [hereinafter Municipal Solid Waste].

[6] *Id.* at 2. The average American generates his or her own weight in municipal solid waste (MSW) every fifty-three days. *See id.*

[7] *Id.*

[8] *Id.*

the United States.[9] The number steadily declined to approximately 1767 operating landfills in the United States in 2002.[10] But declining absolute numbers of repositories belie the new larger mega-fills. While the number of landfills in the United States has been declining, their waste capacity has remained relatively constant. The currently available landfill capacity in the United States is estimated at 3.6 billion tons, which at current rates of disposal would provide twenty-eight years of additional disposal capacity.[11]

Fourth, the bulk of MSW eventually degrades into methane molecules.[12] About two thirds of the total MSW is organic matter that will degrade to release methane under anaerobic conditions.[13] In 2002, landfills accounted for 6.9 million metric tons of methane emitted annually.[14] These emissions can be captured and employed productively as a methane gas energy source, collected and flared for no productive purpose, or left alone to migrate into the environment as a potent greenhouse gas.[15]

In addition to landfilling MSW and then capturing the methane produced as an energy fuel, the organic material can be directly combusted to release energy. Fourteen percent of MSW in the United States is incinerated; occasionally, incineration is coupled with a turbine to produce electricity.[16] In 2002, there were 107 active waste-to-energy combustion facilities in operation in the United States.[17] The most significant deployment of waste-to-energy combustion facilities to handle

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[9] Jay Finegan, *Down in the Dump*, INC, Sept. 1, 1990, at 1, *available at* http://www.aquafoam.com/papers/Downinthedump.pdf.

[10] MUNICIPAL SOLID WASTE, *supra* note 5, at 9.

[11] *See* Scott M. Kaufman et al., *The State of Garbage in America*, 45 BIOCYCLE 31, 38 tbl.7 (2004).

[12] *See* Steven Ferrey, *Nothing but Net: Renewable Energy and the Environment,* MidAmerican *Legal Fictions, and Supremacy Doctrine*, 14 DUKE ENVTL. L. & POL'Y F. 1, 10 n.34 (2003).

[13] U.S. Environmental Protection Agency, Municipal Waste: Basic Facts, http://www.epa.gov/msw/facts.htm (Mar. 2, 2007) [hereinafter MSW Basic Facts]. The composition of typical MSW is 34.2% paper, 13.1% yard waste, 11.7% food waste, 5.7% wood, 11.9% plastics, and 7.3% textiles, leather, and rubber, and the remainder metals, glass, and other materials. *Id.*

[14] U.S. Department of Energy, Energy Information Administration, Methane Emissions, http://www.eia.doe.gov/oiaf/1605/gg03rpt/methane.html (Apr. 29, 2004).

[15] U.S. ENVTL. PROT. AGENCY, EPA 430-B-96-0004, TURNING A LIABILITY INTO AN ASSET: A LANDFILL GAS-TO-ENERGY PROJECT DEVELOPMENT HANDBOOK 1–2 (1996), *available at* http://www.epa.gov/lmop/res/pdf/hand_1.pdf.

[16] MSW Basic Facts, *supra* note 13; MUNICIPAL SOLID WASTE, *supra* note 5, at 10 fig.6. Combustion reduces waste by seventy-five percent of its volume, leaving a residual ash for disposal in landfills. MSW Basic Facts, *supra* note 13.

[17] Kaufman et al., *supra* note 11, at 40.

MSW is in New England, where thirty-four percent of the waste stream is handled in this manner.[18] Waste-to-energy combustion of MSW in the United States generated 289 trillion British thermal units (BTU) of energy in 2001, representing approximately 0.3% of total U.S. electricity demand.[19] There is a third destination alternative: thirty-one percent of the MSW waste stream in the United States is recycled or composted, almost a twofold increase from a decade earlier.[20]

## I. Every Landfill Is a Brownfield

### A. *Why Municipalities May View Landfills as Hazardous Liabilities*

#### 1. The Presence of Household Hazardous Waste

All industrial nations are neck-deep in waste. What poses a potential liability for municipalities is that (1) so called "sanitary" MSW is actually hazardous, and (2) these landfills are leaking.[21] All waste, whether liquid, gaseous, or solid, is characterized as solid waste.[22] Some solid wastes are sanitary, although others are hazardous. Municipal garbage collected from households is designated as municipal solid waste and is appropriately disposed of in sanitary landfills.[23]

Roughly thirty percent of the total waste collected in some communities are household wastes.[24] Detailed surveys indicate that approximately three percent of MSW is recycled; the remainder is thrown

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[18] *Id.* at 34. Rocky Mountain and Midwest regions use this technology the least. *Id.* The areas where the largest percentage of waste is landfill are the Rocky Mountain region with ninety percent of MSW waste stream landfilled, the Midwest with seventy-five percent of the waste stream landfilled, the Great Lakes region of the Midwest with sixty-eight percent of the waste stream landfilled, and the South with sixty-nine percent of the waste stream landfilled. *Id.*

[19] Ctr. for Sustainable Sys., Municipal Solid Waste Factsheets 2 (2005), http://css.snre.umich.edu/css_doc/CSS04-15.pdf.

[20] *See* Municipal Solid Waste, *supra* note 5, at 3. Combustion reduces waste by ninety percent of its volume, leaving a residual ash for disposal in landfills. *Id.*; *See* MSW Basic Facts, *supra* note 13.

[21] Landfills: Hazardous to the Environment, http://www.zerowasteamerica.org/Landfills.htm (last visited Apr. 22, 2007).

[22] U.S. Environmental Protection Agency, Summary of the EPA Municipal Solid Waste Program, http://www.epa.gov/reg3wcmd/solidwastesummary.htm (Feb. 8, 2007).

[23] U.S. Environmental Protection Agency, Solid Waste: Laws and Regulations, http://www.epa.gov/region09/waste/solid/laws.html (Feb. 16, 2007).

[24] *See, e.g.*, Cal. Recovery Sys., Inc., North Santa Clara County Comprehensive Waste Characterization Study (1982–83): Final Summary Report, Rep. No. 83-10, at 12 (Jan. 1984) (discussing constituents of household waste). This study analyzes seasonal samples of a variety of waste streams in California. *See id.*

out.[25] In 1976, the United States officially produced and placed in landfills more than 360 million tons of solid waste created by municipal, commercial, and industrial sources.[26] Congressional records from proceedings on the Resource Conservation and Recovery Act (RCRA) estimate that over 11 billion tons of waste are generated every year in the United States.[27] In 1999, the United States produced approximately 545 million tons of solid waste, 374 million tons of which were placed in landfills.[28] On a per capita basis, each American creates approximately 4.5 pounds of MSW each day.[29] This amount varies depending on the "degree of urbanization,"[30] the season,[31] the average income level,[32]

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[25] J.C. Glaub et al., *Comprehensive Waste Characterization on a Quarterly Basis*, 1984 NAT'L WASTE PROCESSING CONF. 195, 198 (1984).

[26] Robert A. Griffin et al., *Attenuation of Pollutants in Municipal Landfill Leachate by Passage Through Clay*, 10 ENVTL. SCI. & TECH. 1262, 1262 (1976). This disposal had an annual cost of more than $4.5 billion. *Id.* Additionally, each day Americans flush an estimated 6.8 billion gallons of sewage. Judy Licht & Jeff Johnson, *Without a Paddle*, 17 ENVTL. ACTION 10, 13 (1985).

[27] S. REP. NO. 102-301, at 2 (1992) (Comm. Rep.). Of these 11 billion tons, 7 billion were industrial wastes, 4 billion were wastes generated from generators including mines, electric utilities, and oil and gas extraction and production, 250 million were subtitle C hazardous wastes, and 180 million were municipal wastes. *Id.*

[28] Edward W. Repa, *The U.S. Solid Waste Industry, How Big Is It?*, WASTE AGE, Dec. 1, 2001, http://www.wasteage.com/mag/waste_us_solid_waste/index.html.

[29] MSW Basic Facts, *supra* note 13. This definition of MSW includes residential and commercial waste. *Id.* Reported MSW generation as of 1986 ranges from about 2.3 to 6.58 pounds per capita per day (lb./cap/day). BUREAU OF SOLID WASTE DISPOSAL, DEP'T OF ENVTL. QUALITY ENG'G, COMMON-WEALTH OF MASS., WASTE COMPOSITION STUDIES 1, 6 (1986) [hereinafter WASTE COMPOSITION STUDIES]. The study reported, "Where residential waste can be separately identified, it ranges from about 1.4 to 2.8 lb./cap/day." *Id.*

[30] WASTE COMPOSITION STUDIES, *supra* note 29, at 7. To account for the effect of community size on waste generation, "a desktop study of materials recovery in Vermont and New Hampshire assumed that generation was 2.4 lb./cap/day in communities of less than 4,500 persons, [and] 2.8 lb./cap/day in communities larger than 4,500" persons. *Id.* A Dane County Wisconsin Solid Waste Plan also "found that generation rates were lower in rural areas than in urban areas." *Id.* To calculate "overall county generation rates, the Dane County planners assumed" the following generation rates: "2.2 lb./cap/day in urban areas of 10,000 or more; 1.6 lb./cap/day in towns of 2,500 to 10,000; 1.0 lb./cap/day in rural areas with incorporated places; 85 lb./cap/day in very rural areas with one or fewer incorporated places of 1,000 or less." *Id.* at 8. In another study, Delaware landfill records showed "annual waste generation of 880 lb./cap/year in rural areas, and 2,400 lb./cap/year in wealthy coastal areas." *Id.* at 8.

[31] *Id.* A study of waste generation in Portland, Maine "found that total waste generation could vary seasonally from 80 to 120 percent of the average monthly rate . . . ." *Id.* The study reasoned that the "seasonal recreational population may cause extensive seasonal variation." *Id.*

[32] *Id.* Although noting that income levels cannot provide a simplistic explanation for waste generation, the Milwaukee Garbage Project "reported that lower income households appear to generate more household waste than middle or upper income households. This

and level of economic activity.[33] In 1984, 133 million tons of this waste were MSW;[34] as of 2003 it had climbed to 236.2 million tons annually.[35] In 2005, 245 million tons of this waste was MSW produced by U.S. industries, residents, businesses, and institutions.[36] Nearly 131 million tons of the total MSW generated domestically was deposited in landfills.[37]

Estimates of the quantity of waste that is hazardous vary. In the United States, more than 1.5 billion tons of hazardous materials, including gasoline and radioactive materials, are transported by land, sea, and air annually.[38] In 1982, the Environmental Protection Agency (EPA) estimated that over 20,000 hazardous waste generators produce upwards of 40 million metric tons of hazardous waste annually in the United States,[39] although the U.S. Office of Technology Assessment (OTA), a congressional agency, places the amount at approximately 255 to 275 million tons per year.[40] That is, the OTA believed that six times more hazardous waste is being produced than EPA thought it was regulating.[41]

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was attributed to different consumption patterns that resulted in the use of more packaging." *Id.*

[33] *Id.* "The Dane County [Solid Waste Management] Plan noted a correlation between the rate of increase of the [gross national product] and per capita solid waste generation rates. In *Wastepaper: The Future of a Resource*, [a 1982 report], Franklin Associates found an increase in per capita waste generation with time . . . and projected that it would rise to 3.66 lb./cap/day by 1990." *Id.*

[34] Bureau of Nat'l Affairs, *EPA Study Finds Older, Unlined Landfills More Likely to Adversely Affect Environment*, 17 Env't Rep. (BNA) 1221, 1222 (Nov. 21, 1986).

[35] Municipal Solid Waste *supra* note 5, at 2.

[36] At present, thirty-two percent of this MSW is recycled, fourteen percent is incinerated at combustion facilities, and fifty-four percent is disposed of in landfills. MSW Basic Facts, *supra* note 13.

[37] Municipal Solid Waste, *supra* note 5, at 2.

[38] U.S. Office of Tech. Assessment, Transportation of Hazardous Materials 3 (1986).

[39] Samuel S. Epstein et al., Hazardous Waste in America 7 (1982); U.S. Environmental Protection Agency, Wastes: Basic Facts About Waste, http://www.epa.gov/epaoswer/osw/facts.htm (Feb. 22, 2006).

[40] Lawrence Mosher, *EPA Still Doesn't Know the Dimensions of Nation's Hazardous Waste Problem*, Nat'l J., Apr. 16, 1983, at 796.

[41] *See id.* EPA officials in 1983 claimed to regulate only 40 to 45 million tons of hazardous waste. *Id.* at 797. Inadequate recordkeeping makes it impossible for the EPA to tell whether waste generation is increasing or decreasing. *See* Bureau of National Affairs, Inc., *Data on Waste Generation, Management Said Inadequate for Key Policy Decisions,* 17 Env't Rep. (BNA) 1784, 1784 (Feb. 20, 1987).

Although the composition of residential waste varies seasonally,[42] approximately fifty percent is various paper products, five to ten percent is plastics, twenty to thirty percent is yard waste, and three to nine percent is food, while remaining shares are ferrous metals (three to six percent), aluminum (0.6-1.3%), glass (four to eleven percent), and miscellaneous inorganic matter (0.1-3%), as illustrated in Table 1, *infra*.[43] Approximately seventy-four percent of the gross volume of MSW would be suitable for combustion if, in lieu of landfilling, it became part of a waste-to-energy conversion process.[44] Table 2 illustrates the elemental share of organic materials in MSW.

Chemicals contained in trash include pesticides, paints, degreasers, preservatives, detergents, oven cleaners, insecticides, and even shampoos sold ubiquitously over the counter to consumers.[45] Research conducted in Nassau County, New York, estimates that in that county alone, hardware, department, and automotive stores annually sell an estimated 288,000 gallons of consumer products containing organic carcinogens, suspected carcinogens, or other harmful organic materials.[46] Consumers dump some of these chemical compounds directly onto the ground, others are discharged into cesspools or septic systems and escape into the ground, and still others are disposed of in household trash and are collected for disposal at MSW landfills.

Telephone surveys reveal that the most commonly used and discarded hazardous household substances, in descending order, are household cleaners, pesticides, auto and furniture polishes, paint and paint thinners, motor oil, chemical drain openers, antifreeze, wood preservatives, and herbicides.[47] Paint products, solvents, batteries, pes-

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[42] *See* CAL. RECOVERY SYS., *supra* note 24, at 15 tbl.1. In warmer months yard waste increases, food waste decreases, and other wastes show various fluctuations in volumes. *See also* Glaub et al., *supra* note 25, at 204.

[43] *See* Glaub et al., *supra* note 25, at 199–202 (finding similar composition of residential waste); *infra* Appendix, tbl.1. The organic share is approximately forty-two percent carbon and forty percent oxygen. Glaub et al., *supra* note 25, at 199–202.

[44] Glaub et al., *supra* note 25, at 198. Residential solid waste has a heating value of approximately 4200 BTU per pound. *Id.* at 208.

[45] *See* U.S. Environmental Protection Agency, Household Hazardous Waste: Steps to Safe Management, http://www.epa.gov/epaoswer/non-hw/househld/hhw.htm (June 21, 2006); *see also* U.S. Environmental Protection Agency, List of Common HHW Products, http://www.epa.gov/msw/hhw-list.htm (Feb. 22, 2006).

[46] SUSANNE L. MACKAY, NASSAU COUNTY DEP'T OF HEALTH, REPORT ON SURVEY OF CONSUMER PRODUCTS CONTAINING OR SUSPECTED OF CONTAINING HARMFUL ORGANIC CHEMICALS AND HAVING THE POTENTIAL OF CONTAMINATING THE GROUNDWATER OF NASSAU COUNTY, NEW YORK 4 (1979).

[47] Association of Bay Area Governments, *The Disposal of Hazardous Wastes by Small Quantity Generators*, *in* IN-DEPTH SUMMARY OF SELECTED HOUSEHOLD HAZARDOUS WASTE CHAR-

ticides and herbicides, adhesives, aerosols, alcohols, oils and grease, polishes and waxes, cosmetics, and dyes contain dozens of metals as well as halogenated and nonhalogenated compounds,[48] some of which qualify as hazardous substances under federal law.[49] A number of elemental metals in significant concentrations are found in MSW,[50] and both soluble fluorides and chlorides are found at average concentrations of 1900 parts per million (ppm).[51] The organic fraction of MSW contains both pesticides and herbicides.[52] Some pesticides found in MSW are decades old and have since been banned from commercial use.[53] These concentrations are displayed in Table 3, *infra*.

An examination of the waste stream in King County, Washington, identified approximately 1500 distinct potentially hazardous items in waste loads from ninety-one trash collection vehicles.[54] On a nationwide basis, very little effort is made to collect and contain household hazardous waste (HHW) separately, and even when the effort is made, very few households typically participate in collection initiatives.[55] Over the past decade the number of HHW collections in the United States has been on the rise.[56] In 1997, more than 3000 collection pro-

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acterization Studies 3 (1985) (on file with author) [hereinafter Summary of Studies]; *see also* Cal. Recovery Sys., Inc., Characterization And Impacts of Nonregulated Hazardous Wastes in Municipal Solid Waste of King County 4, 15, 17 (1985) [hereinafter Municipal Solid Waste of King County] (listing different categories of hazardous household substances and the estimated amount of each category in the King County waste stream).

48 Municipal Solid Waste of King County, *supra* note 47, at 30–41. Halogenated compounds include one of the following five elements: fluorine, chlorine, bromine, iodine, or astatine. Halogenated contaminants pose a greater risk to the environment.

49 *See* Designation of Hazardous Substances, 40 C.F.R. § 116.4 (2005).

50 Cal. Recovery Sys., *supra* note 24, at 41–43. Metals detected in the 10 to 100 parts per million (ppm) range (by volume) include aluminum, iron, barium, copper, manganese, magnesium, zinc, bismuth, chromium, lead, strontium, antimony, cerium, gallium, germanium, molybdenum, nickel, platinum, tin, arsenic, mercury, and vanadium. *Id.*; *see also* Glaub et al., *supra* note 25, at 210 (providing an elemental analysis of MSW).

51 Cal. Recovery Sys., *supra* note 24, at 43; Glaub et al., *supra* note 25, at 210.

52 *See* Glaub et al., *supra* note 25, at 214–15 (providing a comprehensive pesticide and herbicide analyses of MSW). Chlorinated pesticides detected in relatively dilute concentrations include aldrin, BHC, chlordane, DDE, DDT, dieldrin, endrin, heptachlor, haptachlor epoxide, kepone, methoxychlor, mirex, PCB, and toxaphene. *Id.* at 215. Phosphate pesticides detected in significant concentrations include diazinon, ethyl parathion, malathion, and methyl parathion (this list is in the parts per million range). *Id.* Chlorinated phenoxyacid herbicides detected include: 2,4-D; 2,4,5-T; and 2,4,5-TP. *Id.*

53 Municipal Solid Waste of King County, *supra* note 47, at 22.

54 *See generally id.*

55 *See* 40 C.F.R. § 302.4 (2005); Paula J. Meske, *The Solid Waste Dilemma: Municipal Liability and Household Hazardous Waste Management*, 23 Envtl. L. 355, 364–66 (1993).

56 Meske, *supra* note 55, at 365 n.57.

grams were documented in all fifty states.[57] While numbers indicate that there has been an increase in HHW collection initiatives, even in communities where programs are well-established, participation remains voluntary and inconsistent. Such low participation rates will not begin to remove hazardous waste from the MSW stream. Hazardous substances are in landfills.

2. Landfill Leakage

If dumped in a municipal solid waste landfill, these chemicals can seep or "leach"[58] into the ground and into the groundwater. After a thorough examination of hazardous constituents in household waste, one research team concluded that "[t]he volatile organic chemical species likely to contaminate groundwater enter the waste stream primarily in the form of paint and paint products, solvents, and cosmetics. Lead enters the waste stream primarily in the form of paint and paint products and in the form of batteries."[59] Volatile organic solvents (VOCs) are common in many household products. EPA lists many of these chemical compounds as priority pollutants, subject to direct regulation as toxic chemicals.[60] When saturated in soil or blended with groundwater streams, VOCs remain present for extended periods of time. VOCs in the ground pose a special threat when they become mobile in the soil and reach the groundwater.[61]

The stability of VOCs in the ground is influenced by temperature, light, soil composition, moisture, sedimentation, and the presence or absence of oxygen.[62] VOCs are not readily biodegraded or absorbed

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[57] U.S. Environmental Protection Agency, Household Hazardous Waste: HW Facts and Figures, http://www.epa.gov/msw/hhw.htm (Mar. 6, 2007).

[58] "Leachate" is "any liquid, including any suspended components in the liquid, that has percolated through or drained from hazardous waste." 40 C.F.R. § 260.10; *see* Danielle M. Bergner, Comment, *The Electronic Waste Recycling Act of 2003: California's Response to the Electric Waste Crisis*, 88 Marq. L. Rev. 377, 384 n.55 (2004). Such a phenomenon is described as a "leaching" of contaminants.

[59] Municipal Solid Waste of King County, *supra* note 47, at 28.

[60] *See* 40 C.F.R. § 302.4. Typical low-solubility volatile organics found in contaminated wells include aliphatics (including propane, straight, or branched chain hydrocarbons), aromatics (benzene, toluene, ethylbenzene, etc.), chlorinated aromatics (mono- and dichlorobenzenes, etc.), halogenated alkanes (chloroethane, mythelene chloride, 1,1- and 1,1,1- chloroethanes, trihalomethanes), and chlorinated ethenes (vinyl chloride, vinylidene chloride, cis- and trans-1,2-dichloroethylene, trichloroethylene, and te-trachloroethylene). *Id.*

[61] *See* Gretchen V. Sabel & Thomas P. Clark, *Volatile Organic Compounds as Indicators of Municipal Solid Waste Leachate Contamination*, 1984 Waste Mgmt. & Res. 119, 119–20 (1984).

[62] Mackay, *supra* note 46, at 6.

into the soil, and they can move rapidly through soil to groundwater.[63] In low concentrations these compounds can be degraded anaerobically, but not aerobically.[64]

Minnesota data indicate that there is no chemical distinction between the type and amount of organic pollutants present in the rural regions—where there is no manufacturing waste—and urban landfills surveyed.[65] Rural landfills, which contain only *household* waste, therefore pose contamination problems identical to urban landfills, which contain both household and industrial waste. A congressional study surveying MSW facilities leaching hazardous substances revealed that "[g]enerally the contaminants found at the [sanitary] facilities and their frequency resemble what has been found at all [Superfund] sites. . . . All the information suggests that solid waste sites on the NPL [National Priority List] score similarly to NPL sites that dealt solely with hazardous wastes."[66]

Although there are fewer toxic constituents per unit of volume of MSW than industrial waste, the enormous tonnage of MSW land-filled annually yields large quantities of potentially toxic elements. There is no definitive survey measuring the percentage of household waste that is hazardous, yet a waste analysis by one of the most experienced American waste consulting teams indicates that "[h]azardous wastes make up less than 0.1% by weight of the municipal waste stream."[67] In a more detailed 1984 study, the Los Angeles County Sanitation Districts estimated that 0.00147% of all refuse discarded at five of its mu-

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[63] Edward J. Bouwer et al., *Anaerobic Degradation of Halogenated 1- and 2-Carbon Organic Compounds,* 15 Envtl. Sci. & Tech. 596, 596 (1981); Sabel & Clark, *supra* note 61, at 121 (relying on an unpublished 1983 research report on groundwater contamination for the Minnesota Pollution Control Agency); *see also* Frances Parsons & Gladys B. Lage, *Chlorinated Organics in Simulated Groundwater Environments*, Research & Tech., May 1985, at 52, 57, 59 (concluding that some volatile organic solvents (VOCs)—e.g., chlorinated alkenes—are particularly resistant to biotransformation and are therefore troublesome pollutants because they persist in the groundwater).

[64] *See* Bouwer et al., *supra* note 63, at 599.

[65] Sabel & Clark, *supra* note 61, at 120–21 & tbl.I.

[66] *See* Steven Ferrey, *The Toxic Time Bomb: Municipal Liability for the Cleanup of Hazardous Waste*, 57 Geo. Wash. L. Rev. 197, 208 (1988) (quoting U.S. Office of Tech. Assessment, Superfund Strategy 131 (1985)).

[67] Summary of Studies, *supra* note 47, at 12 (construing a 1985 project feasibility report prepared for the Northern Santa Clara County Solid Waste Management Authority based on the study by Glaub et al., *supra* note 25).

nicipal facilities qualified as hazardous.[68] These estimates, however, may be low.[69]

The great bulk of hazardous waste in the United States is dumped in landfills.[70] About ninety percent of this hazardous material, however, was improperly disposed, and continues to pose a potential health threat.[71] Rules passed between 1980 and 1985 led to the closure of thousands of the nation's landfills because they threatened to contaminate nearby groundwater supplies.[72] In 1985, the OTA concluded that "many, if not most, solid waste facilities have [posed] and will continue to pose threats associated with the release of hazardous substances into the environment."[73]

In a study conducted for the Office of Management and Budget, EPA found that more than sixty percent of the nation's known hazardous waste facilities failed to comply with federal groundwater monitoring requirements,[74] and more than twenty percent of inspected landfills are cited for contaminating either the air or the water.[75] Experts also posit that the liners placed in landfill sites to protect against leakage are more permeable than anticipated, resulting in potential leachate migration problems.[76]

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[68] *See* Ferrey, *supra* note 66, at 210 (citing a 1986 report by the Office of Solid Waste).

[69] *See id.* The Los Angeles project was concerned with identifying commercial size quantities, and therefore looked only for containers greater than one gallon or whole boxes containing hazardous waste. *See id.* This tends to undercount the actual volume of hazardous constituents. *See id.*

[70] *See supra* Part I.A.1.

[71] *See* EPSTEIN ET AL., *supra* note 39, at 9 tbls.1 & 2 (1982).

[72] *See* 40 C.F.R. § 265 (2005) (defining interim status standards for owners and operators of hazardous waste treatment, storage, and disposal facilities). Interim status was a mechanism at the 1976 passage of RCRA to "grandfather" the temporary operation of existing facilities until EPA issued a permit. *See* 42 U.S.C. § 6925(e) (2000).

[73] Ferrey, *supra* note 66, at 213–14 (quoting a 1985 Office of Technology Assessment (OTA) study).

[74] Mosher, *supra* note 40, at 796.

[75] *See* Bureau of Nat'l Affairs, *supra* note 34, at 1222 (stating that 2.2423 percent of 11,540 landfill facilities inspected in 1984 were cited for violations of air or water quality contamination).

[76] David Anderson, *Does Landfill Leachate Make Clay Liners More Permeable?*, CIVIL ENGINEERING-ASCE, Sept. 1982, at 66–69. Anderson explains that the permeability of clay liners is usually tested only with relatively pure water. *Id.* at 66. Actual leachates generated in landfills, however, may be highly contaminated or contain organic liquids, greatly increasing the permeability of the clay liners. *Id.* In reauthorizing the Resource Conservation and Recovery Act (RCRA) in 1984, Congress took notice of the real and imminent danger of hazardous contamination at MSW sanitary landfills:

> Subtitle D facilities are the recipients of unknown quantities of hazardous waste and other dangerous materials resulting from the disposal o[f] household

About twenty-three percent of the National Priority List (NPL) Superfund sites are or were MSW disposal facilities.[77] In 1998, EPA estimated that municipal landfills constituted twenty percent of the sites on the NPL, noting further that municipalities were otherwise involved as "generators, transporters, or arrangers" at twenty-five percent of the NPL sites then in existence.[78]

The OTA acknowledges that hazardous substances are leaching from a significant percentage of sanitary solid waste facilities, and concludes that household waste is a source of these hazardous substances.[79] The OTA estimates that there are 75,000 operating, and 150,000 closed industrial landfills, and 176,242 operating and 4731 closed surface impoundments.[80] Of the 621,000 open and closed solid waste facilities, the OTA conservatively estimates that 17,400 to 34,800 MSW sites may eventually require cleanup under Superfund.[81]

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> waste, small quantity generator wastes and illegal dumping. Since construction, siting, and monitoring standards for these facilities are either nonexistent or far less restrictive than those governing hazardous waste disposal facilities, environmental and health problems caused by Subtitle D facilities are becoming increasingly serious and widespread. A high proportion of sites listed on the National Priority List were sanitary landfills. Without the additional environmental protection that the implementation of this provision will provide, even more Subtitle D facilities are destined to become Superfund sites.

H.R. Rep. No. 98-1133, at 117 (1984) (Conf. Rep.), *as reprinted in* 1984 U.S.C.C.A.N. 5649, 5688.

[77] Memorandum from Steven A. Herman, Assistant Adm'r, Office of Enforcement and Compliance Assurance, U.S. Envtl. Prot. Agency, Transmittal of Policy for Muncipality and Municipal Solid Waste CERCLA Settlements at NPL Co-Disposal Sites 4 (Feb. 5, 1998) (stating that there were 250 MSW facilities on the National Priorities List (NPL)), *available at* http://www.epa.gov/compliance/resources/policies/cleanup/superfund/munic-solwst-mem.pdf. The NPL currently contains 1245 listed sites and five sites proposed for listing, for a total of 1175 sites. U.S. Environmental Protection Agency, EPA Adds Five and Proposes Five Sites to Superfund's National Priorities List, http://www.epa.gov/superfund/news/npl_030707.htm (Mar. 7, 2007).

[78] John L. Tatum, Solid (and Municipal Solid) Waste Taxonomy, http://www.tatum.com/Resource/msw_taxonomy.htm (Dec. 6, 1997).

[79] *See* Ferrey, *supra* note 66, at 208.

[80] *Id.* at 126.

[81] *Id.*

## II. What Goes on at a Landfill Stays at a Landfill? Landfill Gas as an Energy Resource

### A. *Overview of the Chemical Process*

Americans annually dispose of millions of tons of waste in thousands of landfills across the country.[82] Because waste is composed of a high percentage of organic materials, including paper, food scraps, and yard waste, over time, bacterial decomposition of organic material, the volatilization of certain wastes, and chemical reactions within the landfill create copious quantities of gas.[83] This landfill gas is comprised primarily of carbon dioxide and forty to sixty percent methane, while containing smaller amounts of nonmethane organic compounds (NMOCs) and some other trace organic elements.[84] For comparison, pipeline natural gas contains about ninety percent methane.[85]

Landfill gas (LFG) constituents can pose health and safety problems. Methane in high concentrations can create an explosion hazard.[86] LFG contains a variety of toxic gases and carcinogens that can have detrimental effects on the health of the surrounding community.[87] Globally, methane and carbon dioxide released from landfills each are greenhouse gases contributing significantly to global warming.[88] While both carbon dioxide and methane contribute to global warming, methane has twenty-one times the global warming potential of carbon dioxide.[89]

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[82] Cliff Chen & Nathanael Greene, Natural Res. Def. Council, Is Landfill Gas Green Energy? 1 (2003). In 2000, the United States deposited 231.9 million tons of municipal waste. *Id.* Of that waste, fifty-five percent was landfilled, thirty percent was recycled, and fifteen percent was combusted. *Id.* fig.1.

[83] Agency for Toxic Substances and Disease Registry, Landfill Gas Primer: An Overview for Environmental Health Professionals 3 (2001), *available at* http://www.atsdr.cdc.gov/HAC/landfill/html/ch2.html.

[84] Energy Info. Admin., Renewable Energy Annual 1996, ch. 10 tbl.28 (1997), *available at* http://www.eia.doe.gov/cneaf/solar.renewables/renewable.energy.annual/chap10.html [hereinafter REA 1996].

[85] The Need Project, Secondary Energy Infobook 29 (2006), *available at* http://www.need.org/needpdf/infobook_activities/SecInfo/NGasS.pdf.

[86] REA 1996, *supra* note 84.

[87] *See generally* Standards of Performance for New Stationary Sources, 40 C.F.R. § 60 (2006).

[88] *See* REA 1996, *supra* note 84.

[89] Steven Ferrey & Anil Cabraal, Renewable Power in Developing Countries: Winning the War on Global Warming 9 tbls.1 & 2 (2006).

## B. *Productive Energy Applications*

### 1. Exploiting the Energy Potential of Landfill Gas Brownfields

After LFG is collected (in the vast majority of landfills in the United States and the world it is *not* collected) there are two disposal options. The first is an open flare system in which the gas is burned.[90] The second option is using the gas for useful energy applications either in the gaseous form or as the fuel for electric production. Some states allow LFG projects to make direct sales of the methane to third-party customers without being regulated as a public utility.[91] Small LFG-to-electricity projects are exempt from regulation in Connecticut, Florida, and Wisconsin.[92]

The EPA encourages, but does not require or provide additional incentives for, the second option. Burning LFG converts methane into carbon dioxide, a gas less than five percent as damaging as methane in terms of global warming potential.[93] EPA estimates that each megawatt of electricity generated from LFG has the same impact of planting 12,000 acres of forest, removing 8800 cars per year, or eliminating the need for 93,000 barrels of oil.[94]

EPA maintains a database of more than 2300 landfills that are potential LFG-to-energy locations in the United States.[95] EPA Landfill

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[90] *See* 40 C.F.R. § 60.18. The requirements of the flare system include having a flame at all times and having no visible emissions except for less than five minute intervals not within a two consecutive hour period. *Id.* Additionally, if a flare system is employed, the equipment must have a heat sensing device that indicates a constant flame and a device that measures flow into, or bypass of, the flare. *Id.* § 60.756. The gas flow rate into the flare must be measured at fifteen minute intervals. *Id.* If a bypass line is installed, it must be visually inspected once every month. *Id.*

[91] *See, e.g.*, Envtl. Prot. Agency, Pennsylvania State Primer: A Primer for the Commonwealth of Pennsylvania for Developing Landfill Gas Utilization 23 (2005), *available at* http://www.epa.gov/lmop/res/pdf/st_primers/penn_pmr.pdf.

[92] Energy and Environmental Analysis, Inc., State Non-Utility Generator Siting Regulations, http://www.eea-inc.com/rrdb/DGRegProject/Siting.html (last visited Apr. 22, 2007). Connecticut exempts projects up to twenty-five megawatts, Florida up to seventy-five megawatts, and Wisconsin up to one hundred megawatts. *Id.*

[93] *See* Ferrey & Cabraal, *supra* note 89, at 9 tbls.1 & 2.

[94] *See* U.S. Environmental Protection Agency, Landfill Methane Outreach Program: (LMOP): Benefits of LFG Energy, http://www.epa.gov/lmop/benefits.htm (Sept. 27, 2006).

[95] U.S. Environmental Protection Agency, LMOP: Landfill and Project Database, http://www.epa.gov/lmop/proj/xls/lmopdata.xls (last visited Apr. 22, 2007); *see* U.S. Environmental Protection Agency, LMOP: Energy Projects and Candidate Landfills, http://www.epa.gov/lmop/proj/index.htm (Feb. 9, 2007). This also provides maps of locations and a costing methodology is available to determine the economic feasibility of development. *See* U.S. Environmental Protection Agency, LMOP: Documents, Tools, and Resources, http://www.epa.gov/lmop/res/index.htm (Mar. 8, 2007).

Methane Outreach Program (LMOP) tracks 395 operating LFG projects in the United States, and identifies more than 570 additional landfills as very good candidates because of their size and methane generation characteristics.[96] These 570 candidate landfills have the potential of generating 695 million cubic feet (mcf) of LFG per day.[97] The challenge is to get these developed amidst a variety of impediments. It is estimated that "each year . . . 421 to 613 billion cubic feet of methane from landfills alone is wasted." That amount of methane could produce up to 4000 megawatts of electricity, enough to power three millions homes.[98]

Additionally, there are 100 landfills that are in the process of constructing LFG electricity projects. The 400 existing LFG projects generate about 9 billion kilowatt-hours (kW-h) of electricity annually, plus also produce approximately 200 mcf per day of LFG for direct thermal purposes.[99] This is equivalent to planting nearly 19,000 acres of forest, saving 160 million barrels of oil, removing 13 million vehicles from the road, or supplying the electricity and heating requirements of approximately 1 million homes.[100]

2. Municipal Sewage Treatment Brownfields

The United States expends $25 billion every year to process and treat 33 billion gallons of wastewater.[101] Many, but not all, cities and towns have sewage treatment facilities. Some of these also constitute brownfields because of contamination. They also consume significant quantities of electricity treating sewage. Treatment works are viewed by many municipalities exclusively as environmental negatives.

However, these facilities also can be adapted or redeveloped into environmental positives. The facilities can offer an energy generation or energy capture opportunity, rather than only being an environmental problem. There are several proven technologies to accomplish energy extraction from sewage.

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[96] *See* LMOP: Energy Projects and Candidate Landfills, *supra* note 95.

[97] U.S. Environmental Protection Agency, LMOP: Landfill Gas Energy Projects and Candidate Landfills, http://www.epa.gov/lmop/docs/map.pdf (Jan. 8, 2007).

[98] Cory M. Gonyo, *Landfill Gas/Methane Gas: A Liability and an Asset*, 1 GREAT PLAINS NAT. RESOURCES J. 149, 152 (1996).

[99] *See* U.S. ENVTL. PROT. AGENCY, LMOP: AN OVERVIEW OF LANDFILL GAS ENERGY IN THE UNITED STATES 12 (2006), *available at* http://www.epa.gov/lmop/docs/overview.pdf.

[100] *Id.*

[101] National Science Foundation, Fuel-Cell Microbes' Double Duty: Treat Water, Make Energy, http://www.nsf.gov/news/news_summ.jsp?cntn_id=100337 (Feb. 23, 2004).

One way to capture heat from raw sewage is to employ a heat pump to extract heat from the hot mixture and distribute the heat.[102] Alternatively, an anaerobic digester collects the methane or "biogas" that bacteria convert consuming organic material anaerobically.[103] The biogas produced is composed of about sixty percent methane, forty percent carbon dioxide, and approximately 0.2% to 0.4% hydrogen sulfide.[104] The methane can be combusted for electricity or used thermally.

Such technologies are in use in the United States, and can be supported by renewable system benefit charges and trust funds, as evidenced by projects such as the Deer Island sewage treatment plant in Boston.[105] This process also is finding application in developing countries in agricultural waste settings to create Carbon-Emission Reductions (CERs) pursuant to the clean development mechanism (CDM) of the Kyoto Protocol.[106]

Other benefits of this energy extraction process include reducing the amount of waste remaining that has to be disposed of, and reducing the odor because volatile compounds have been removed.[107] Sewage solids can be landfilled, burned, or recycled. When biomass—in this example sewage—is heated with little or no oxygen, it combusts, becoming a gas mixture of carbon monoxide and hydrogen known as syngas. This syngas then mixes with oxygen and burns more efficiently than the original solids in the waste stream, and can produce electric energy and/or heat.[108] Plants that use biomass gasification have better

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[102] Alister Doyle, *Oslo's Sewage Heats Its Homes*, PLANET ARK, Apr. 10, 2006, http://www.planetark.com/dailynewsstory.cfm/newsid/35952/story.htm. This technology is in use in Oslo to heat homes and office buildings. *Id.* The untreated sewage flows from the houses and into the system of compressors and condensers which extract heat, which warms water to about ninety degrees Celsius, heating the homes and offices. *Id.* This system can produce eighteen megawatts of heat and can save the burning of 6000 tons of oil a year. *Id.*

[103] Michael Schirber, *Waste Not: Energy from Garbage and Sewage*, LIVESCIENCE, Nov. 3, 2004, http://www.livescience.com/technology/041103_convert_garbage.html.

[104] Chris Henry & Rick Koelsch, *What Is an Anaerobic Digester?*, MANURE MATTERS, Nov. 10, 2001, http://manure.unl.edu/adobe/v7n10_01.pdf.

[105] *See* Massachusetts Water Resources Authority, The Deer Island Sewage Treatment Plant, http://www.mwra.com/03sewer/html/sewditp.htm (last visited Apr. 24, 2007).

[106] *See generally* United Nations Framework Convention on Climate Change, Clean Development Mechanism, http://cdm.unfccc.int/index.html (last visited Apr. 22, 2007).

[107] *See* U.S. ENVTL. PROT. AGENCY, MUNICIPAL SOLID WASTE IN THE UNITED STATES, 1999 FACTS AND FIGURES 115 (2001), *available at* http://www.epa.gov/epaoswer/non-hw/muncpl/pubs/msw99.pdf.

[108] U.S. Department of Energy, Energy Efficiency and Renewable Energy, Biomass Gasification, http://www1.eere.energy.gov/biomass/gasification.html (Oct. 12, 2005) [hereinafter Biomass Gasification].

efficiency of energy capture than plants that burn the waste solids, and also convert sludge to ash, which consumes less landfill space.[109]

Sewage methane also can be used in advanced fuel cell technologies to produce direct current electricity for self-use or for wholesale export to the electric grid. For example, a New York sewage treatment plant employs a 200 kilowatt hydrogen fuel cell to supply enough electricity for sixty homes.[110] Technology research is proceeding on a microbial fuel cell (MFC) which will not only create electricity from the sewage but also treat it.[111]

In most states, all of the technologies that could be deployed at municipal brownfields that consist of either landfills or sewage treatment facilities would be eligible for subsidy pursuant to state renewable system benefit charges/trust funds schemes, or qualify to earn tradable Renewable Energy Credit pursuant to the state Renewable Portfolio Standard.[112] They might also be eligible for Title II Clean Water Act grants for innovative systems.[113]

### C. *Above Ground Energy Capture: Wind Power & Brownfields*

While LFG-to-energy or direct thermal LFG applications might appear to be the logical first choice for use of landfill brownfields in many municipalities, it is not the only choice. Landfills are good sites

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[109] Brendan McAuley et al., *A New Process for the Drying and Gasification of Sewage Sludge*, WATER ENGINEERING & MANAGEMENT, May, 2001, at 18–19, *available at* http://www.waterinfocenter.com/articles/Drying_and_Gas_5_01.pdf.

[110] Andrew Revkin, *Turning Sewage Gas into Electricity and Heat*, N.Y. TIMES, Feb. 7, 1999, Late Edition at 46, *available at* http://www.zetatalk.com/energy/tengy18i.htm. The only byproduct from the process is hot water, which then is used to warm the bacteria, which decomposes the organic gas from the sewage. *Id.* The sewage treatment plant saves natural gas that they would otherwise use as fuel for this process. A plant in Renton, Washington, is using both the digesters and the fuel cells. Miguel Llanos, *Poop Power? Sewage Turned into Electricity*, MSNBC, Jul. 19, 2004, *available at* http://www.msnbc.msn.com/id/5335635.

[111] Gayle Ehrenman, *From Foul to Fuel*, MECH. ENG'G, June 2004, *available at* http://www.memagazine.org/backissues/membersonly/jun04/features/fromfoul/fromfoul.html. The device is a single-chambered plexiglass device which is six inches long and 2.5 inches in diameter. *Id.* Inside of the chamber "eight graphite anodes surround a cathode that is made up of a carbon/platinum catalyst and proton exchange membrane layer fused to a plastic support tube." *Id.* A copper wire then connects to the circuit. The microbial fuel cell (MFC) captures electrons, which are released by the bacteria as they digest the organic matter and converts this into energy; the process also removes about eighty percent of the organic matter from the wastewater. *Id.*

[112] *See infra* Appendix, tbls.4 & 5.

[113] *See* Grants for Construction of Treatment Works, 33 U.S.C. §§ 1281–1301 (2000 & Supp. IV 2004); Biomass Gasification, *supra* note 108. If the new treatment plant project uses innovative or alternative technology, they are allowed up to seventy-five percent federal funding to complete the project. *Id.* § 1282(a).

for consideration of siting wind energy projects. Wind energy projects are possible where a landfill is too small, too old, or not sufficiently deep to allow LFG collection and beneficial use. However, a wind turbine can be placed at, or even on, a landfill that also is collecting LFG for beneficial purposes. A single wind turbine can not only lower a town's energy expenses, but can also result in green-energy certificates that the town can sell to utilities who need to comply with the state's Renewal Energy Portfolio Standard.[114]

Wind turbines consist of two or three blades affixed to a rotor.[115] The rotor is mounted on a shaft that "is typically more than 100 feet high."[116] The wind causes the blades to spin, which turns the rotor.[117] The rotor is attached to a generator which creates a flow of electrons that generates electricity.[118]

Assuming that there is a reasonable wind regime in the location, landfills typically have a significant amount of land area that can provide a buffer of distance to neighboring homes, and in some cases can provide a visual buffer for wind turbines. Landfills also often are raised significantly above ordinary grade, and therefore can represent a relative highpoint topographically in a given community, thus increasing power generation potential. Additionally, landfills typically are zoned in a manner compatible for electric power production.[119]

Despite these apparent possibilities, there is only one landfill in the United States on which there is a wind turbine. That is the Hull Wind II in Hull, Massachusetts, which went on-line in May 2006.[120] Hull Wind II stands at 330 feet and can power approximately 750 homes.[121]

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[114] *See* Stephanie Ebbert, *Wind Turbines Gaining Power: Small Communities, Colleges Plan Projects,* Boston Globe, Feb. 24, 2006, at B1. It is estimated that one wind turbine's green energy certificates can currently be sold to a utility for $100,000. *See id*; *see also* 225 Mass. Code Regs. 14.07 (2005).

[115] Massachusetts Division of Energy Resources, Renewable Energy Programs, http://www.mass.gov/doer/programs/renew/renew.htm (Jan 24, 2006) [hereinafter Renewable Energy Programs].

[116] *Id.*

[117] *Id.*

[118] *Id.*

[119] For a discussion of wind zoning issues, see Professor Ferrey's forthcoming article on land-use barriers to wind projects. Publication expected in 2008.

[120] James F. Manwell, PowerPoint Presentation, The Hull Wind II Project 6 (2006), *available at* http://www.ceere.org/rerl/projects/support/ (follow "Massachusetts Wind Working Group" hyperlink; then follow "Hull Wind II" hyperlink.) The site hosts a single turbine 1.8 megawatt facility. *Id.* at 4.

[121] *See id.* at 4. It is located on top of a capped landfill, known as the George Washington Boulevard Landfill, on the opposite side of town from Windmill Point. *See id.* at 7, 12.

The wind project in Hull, Massachusetts, has a simple 7.5 year payback on the investment, assuming it offsets power retailing at 10¢ per kW-h.[122] However, the project was completely financed by grants and donations; therefore, it had zero capital costs.[123] The energy generated by the turbine saves the town between $250,000 and $425,000 annually.[124]

There are thirty-three wind turbines operating in Massachusetts.[125] The vast majority consist of a single turbine, while the largest is comprised of eight turbines.[126] In Massachusetts, there are municipally-owned wind turbines located in Beverly[127] and Princeton;[128] the City of Lynn plans to build a wind turbine to power its waste-treatment plant, which serves the city and three neighboring communities;[129] and the Town of Orleans would build two turbines to power its water treatment plant.[130] Seventeen municipalities in the state are actively planning wind energy projects and an additional thirty-six other communities have indicated some interest in siting a wind turbine in their town.[131]

## III. Regulatory Controls

There are significant regulatory requirements regarding landfill operation and management. However, far from discouraging productive energy use, these environmental regulatory requirements actually encourage the productive capture and use of landfill gas (LFG) at landfills. The federal section 29 and section 45 tax credits, the former

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[122] *Id.* at 20.

[123] *Id.*

[124] *Id.*

[125] *See* Massachusetts Technology Collaborative, Massachusetts Wind Installations (Interactive Map), http://www.masstech.org/cleanenergy/facilities/facilitiesmapstatewind.htm (last visited Apr. 22, 2007).

[126] *See id.*

[127] Renewable Energy Programs, *supra* note 115. A ten kilowatt turbine stands on the grounds of Beverly High School, along with a one hundred kilowatt photovoltaic system. *Id.* The current wind turbine was installed in 1997 and together with the solar panels save Beverly almost $11,000 annually. *Id.*

[128] *Id.*; *see also* Princeton Municipal Light Department, http://www.pmld.com/Home.htm (last visited Apr. 23, 2007). The farm consists of eight forty-kilowatt turbines standing 100 feet tall near Mount Wachusett in central Massachusetts. Renewable Energy Programs, *supra* note 115. The town meeting approved a proposal to replace the eight turbines with two 1.5-megawatt turbines, which will produce forty times the amount of electricity as the current wind farm. *Id.*

[129] *See* Stephanie Ebbert, *Wind Turbines Gaining Power: Small Communities, Colleges Plan Projects*, Boston Globe, Feb. 24, 2006, at B1.

[130] *Id.*

[131] *Id.*

of which added a subsidy of about 1¢ per kilowatt-hour (kW-h) to electricity generation from LFG, also provided incentives to make the capital investment at landfills to construct LFG projects.[132]

### A. *Resource Conservation and Recovery Act (RCRA)*

RCRA mandates that all large landfills operating after 1991 install a protective cap to prevent gas from escaping.[133] Any landfill constructed or extended after October 1993 is required to install a protective lining around the sides and bottom of the landfill to prevent the lateral migration of LFG and groundwater contamination.[134] RCRA requires that all municipal solid waste landfills have a methane gas concentration of less than "[twenty-five] percent of the lower explosive limit for methane."[135] Methane gas is explosive between five and fifteen percent concentrations.[136] Imminent hazards are deemed to occur where methane releases migrate to buildings or underground utility conducts at a concentration of ten percent of the lower explosive limit (LEL).[137] RCRA also requires that the methane concentration at the facility's property boundary be less than the lower explosive limit for methane.[138]

In order to know whether or not landfills are in compliance with these requirements, the owner/operators of the landfill must conduct a methane-monitoring program.[139] Municipal solid waste landfill facilities must provide a report on their methane concentration levels quarterly.[140] If the methane concentration levels exceed the limits, the owner/operator is required to initiate affirmative steps to correct the problem and must take the proper steps to ensure the health and

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[132] *See* Steven Ferrey, Law of Independent Power § 3:53 (2006).

[133] 40 C.F.R. § 258.40 (2006).

[134] *See id.* § 258.50; Solid Waste Disposal Facility Criteria, Delay of Compliance and Effective Dates, 58 Fed. Reg. 51,536 (Oct. 1, 1993).

[135] Explosive Gases Control, 40 C.F.R. § 258.23 (2006). The regulations define the "lower explosive limit" as the lowest percent by volume of a mixture of explosive gases in air that will generate a flame at twenty-five degrees Celsius and atmospheric pressure. *Id.*

[136] U.S. Envtl. Prot. Agency, Anthropogenic Methane Emissions in the United States: Estimates for 1990 (1993), *available at* http://www.epa.gov/nonco2/reports/anthro-summary.html.

[137] 310 Mass. Code Regs. 40.0321 (2006).

[138] 40 C.F.R. § 258.23.

[139] *Id.* Four factors determine the type and frequency of the monitoring program: the soil conditions, the hydrogeologic conditions surrounding the facility, the hydraulic conditions surrounding the facility and the location of the facility structures and property boundaries. *Id.*

[140] *See id.*

safety of the people surrounding the landfill.[141] A written record of the methane level, and the steps taken to protect human health, must be created within seven days of the detection.[142] The state can order assessment and remedial action.[143] The division of solid waste of the state environmental regulatory agency can require plan application and approval.[144] Post-closure environmental monitoring is required.[145]

## B. *Air Regulation for Landfills*

### 1. New Source Performance Standards for Landfills

The New Source Performance Standards (NSPS) of the Clean Air Act (CAA) applies to any new landfill which began modification or construction after May 30, 1991.[146] Under the NSPS, any landfill that has a design capacity in excess of 2.5 million cubic meters must monitor non-methane organic compound (NMOC) emission rates.[147] If NMOC emission rates exceed fifty megagrams per year, the landfill will be required to implement a LFG collection and control system.[148] An owner must reduce NMOC by ninety-eight weight-percent, or to less than twenty parts per million by volume (ppmv), dry basis as hexane at three percent oxygen.[149] Separate rules apply to landfills that do not come under the NSPS.[150]

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[141] *See id.*

[142] *Id.* Within sixty days of learning of the high methane concentration, the owner/operator must devise and submit a corrective plan that addresses the methane gas release. *Id.*

[143] *See* Mass. Gen. Laws ch. 111, § 150A (2003).

[144] *Id.*

[145] 310 Mass. Code Regs. 19.142 (2006). The regulations afford the state discretion in setting minimum reporting intervals for the levels of methane. 40 C.F.R. § 258.23. The alternative reporting schedule must take into account the unique characteristics of the particular community and the climate and hydrogeologic conditions in and surrounding the area. *Id.*

[146] Designation of Affected Facility, 40 C.F.R. § 60.750(a) (2006).

[147] *Id.* § 60.752(b).

[148] *Id.* § 60.752(b)(2). These regulations provide the standards, record keeping, and reporting requirements for municipal solid waste landfills. *Id.* § 60.752(b)(2)(i)(B).

[149] *Id.*

[150] *Id.* § 60.32(c). Under the New Source Performance Standards (NSPS) and under 40 C.F.R. 51, 52, and 60, landfills that meet certain size and age requirements are required to install and operate an active or passive LFG collection system that meets specified performance criteria—as well as install devices that combust and destroy at least ninety-eight percent of the non-methane organic compounds (NMOCs) in the collected LFG—or reduce the NMOCs concentration in the combustion gases to less than twenty parts per million by volume (ppmv) (dry basis as hexane at three percent oxygen). *Id.* § 60.752(b)(2)(i)(B). Specifi-

Compliance with most of subpart WWW's requirements will be necessary if landfills have accepted waste after November 8, 1987, have a design capacity of more than 2.5 million megagrams and 2.5 million cubic meters, and have a non-methane organic compound emission rate of fifty or more megagrams per year.[151] As there are increasingly fewer but larger landfills there are more landfills required by government regulation to capture and utilize or flare LFG.[152] If the landfill expands from below the threshold to above it, the owner/operator must submit an amended design capacity report within ninety days of the increase in size so that it may now be treated as regulated under subpart WWW.[153]

The owner/operator must calculate a NMOC emission rate and report it annually.[154] If the rate exceeds fifty megagrams then a collection and control system will be required to be installed.[155] The collection and control system must be designed in such a way to ensure capture of the gas generated by the landfill.[156] Control of hazardous air pollutants is required.[157]

Monitoring and testing is required as to gas pressure, flow, temperature, oxygen and nitrogen concentrations, and the operator must calibrate and maintain equipment. Information must be retained for at least five years.[158] Individual permits establish units for emissions of

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cally, landfills that commenced construction prior to May 30, 1991, accepted waste since November 8, 1987, have a design capacity to dispose of greater than 2.75 million tons of solid waste, and are projected to emit more than fifty megagrams per year of NMOCs without controls are subject to the requirements. *Id.* §§ 60.752(c)(1), 60.33(c)(1)–(3).

[151] *Id.* § 60.33(c)(1)–(3). The collection and control system must "(1) Be capable of handling the maximum expected gas generation rate; (2) have a design capable of monitoring and adjusting the operation of the system; and (3) be able to collect gas effectively from all areas of the landfill that warrant control," as well as be capable of reducing NMOC emissions by ninety-eight percent. Standards of Performance for New Stationary Sources, 61 Fed. Regs. 9905, 9907 (Mar. 12, 1996).

[152] *See* LMOP: Energy Projects and Candidate Landfills, *supra* note 95; *supra* notes 9–11 and accompanying text.

[153] 40 C.F.R. § 60.757(a)(3). The report must contain a map indicating the size and location of the landfill and all areas where solid waste may be placed, a calculation of the maximum design capacity that is either specified by state or local permit or by "good engineering practices." *Id.* § 60.757(a)(2).

[154] *Id.* § 60.752(b)(1).

[155] *Id.* § 60.752.

[156] *Id.* § 60.752(b)(2)(ii).

[157] National Emission Standards for Hazardous Air Pollutant (NESHAP): Municipal Solid Waste Landfills, 40 C.F.R. § 63.1955 (2003). Under 40 C.F.R. § 61, a facility is subject to the NESHAP emission requirements if it is classified as an industrial facility. *See* 40 C.F.R. § 61.

[158] *Id.* § 63.753.

NOx,[159] CO, NMOC, PM, $SO_2$, VOC, and opacity (visible emissions).[160] Section 60.753 sets the operating standards for the collection system,[161] and also requires the owner/operator to test the above-ground level of methane concentration to determine that level may not exceed 500 ppm or more above background concentration.[162] After installing a collection and control system, an initial report must be submitted within

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[159] *See* Massachusetts Dept. of Envtl. Prot., App. No. 4V95069, Final Air Quality Operating Permit for Allied Waste Systems, Inc. for Plainville Sanitary Landfill, Mar. 25, 2004 [hereinafter Allied Waste Operating Permit]. A landfill is in theory a source of volatile organic solvents (VOCs) subject to the EPA's Reasonably Available Control Technology (RACT), as per 310 Mass. Code Regs. 7.18 (1), (a), but the RACT regulations do not specify any specific requirements for landfills. 310 Mass. Code Regs. 7.18(1)(a)(2006). Under 310 Mass. Code Regs. 7.19(1), RACT applies only to facilities that have the potential to emit, prior to the application of air pollution control equipment, greater that or equal to fifty tons per year of NOx. *Id.* § 7.19(1)(a).

[160] *E.g.*, Allied Waste Operating Permit, *supra* note 159.

[161] 40 C.F.R. § 60.753. Each wellhead must be operated at a negative pressure unless there is a fire, increased well temperature, some type of synthetic cover being used, or the well is no longer functional. *Id.* § 60.753(b). There are specific temperatures of gas allowed in the wellhead as well as maximum nitrogen and oxygen levels. *Id.* § 60.753(c). The standard for these three may be altered as long there is a showing of data supporting the benefits of the levels employed. *See id.* § 60.755(3)–(5). These three levels must be checked monthly pursuant to the compliance provisions in section 60.755 and section 60.756. *Id.* § 60.755(a)(5). If the levels exceed the limits in the statute or the revised approved levels, corrective action must be taken within five calendar days. *Id.* § 60.755.

[162] *Id.* § 60.753(d). The background concentration is calculated by measuring the methane levels around the perimeter of the landfill, at least thirty meters away from past perimeter wells. *Id.* Measurements are taken both upwind and downwind. *Id.* After establishing the background concentration, testing must be done in thirty meter intervals across the entire property and also must take place at specific areas where there is likely to be a release of methane gas. *Id.* These areas include places where there appear to be distressed vegetation and cracks or other breaks in the cover. *Id.* If the test results indicate a level higher than the standard 500, a record of the exact area where the reading was taken must be documented. *Id.* § 60.755(c)(4). Then, the nearest well must be adjusted so that its collection volume is increased. *Id.* Another reading must be taken ten days after this corrective action. *Id.* The owner/operator has three chances and thirty days to correct the problem. *Id.* If after this time the readings still exceed the authorized levels, more invasive action must be taken to correct the problem. *See id.* This includes potentially replacing the well itself or installing an entirely new collection system. *Id.*

180 days of the start of collection.[163] After the initial report is filed, annual reports must thereafter be filed.[164]

Under NSPS, semi-annual reports must be submitted regarding air limit excedances and gas bypass flow reports.[165] Criminal liability can be imposed on the landfill owner if it commits a knowing violation of the CAA, or knowingly releases hazardous air pollutants, a violation punishable by a sentence of up to five years in prison.[166] The CAA also authorizes significant civil penalties of up to $27,500 for each violation.[167]

### 2. State Air Requirements

Massachusetts law requires an annual registration of emission sources.[168] The owner/operator must keep for five years on-site, or off-site if not retrievable in four hours, up-to-date records of the design capacity report, the current amount of solid waste and the year-by-year waste acceptance rate.[169] Permits can require that copies of all standard operating and maintenance procedures be kept on-site, and records of maintenance be maintained on-site.[170]

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[163] *Id.* § 60.757(f). The initial report must contain a diagram of the collection system indicating the location of each device inserted into the ground to collect the gas. *Id.* § 60.757(g)(1). Included in this plan are areas that may in the future house collection devices if known. *Id.* For areas where no collection device is being installed the report must state the specifications resulting in no need for collection in that particular area. *Id.* § 60.757(g)(3). The initial report must also outline a plan for increasing the collection of gases should emissions become greater than the current system can handle and provisions for the control of offsite migration of gases. *Id.* § 60.757(g)(5)–(6).

[164] *Id.* § 60.757(b). The reports must contain the value and length of time that any measurements exceed stated limits. *Id.* § 60.757(f)(1). This includes NMOC, temperature, and nitrogen and oxygen levels, among other factors. *Id.* §§ 60.756, 60.757(f)(1). It must also state the duration of time when the gas stream bypasses the control system. *Id.* § 60.757(f)(2). If the control device breaks down for a period of longer than 1 hour, this must be recorded along with down time. *Id.* § 60.757(f)(3). Any instances where the collection mechanism was not operating for a period of five days or more must be documented. *Id.* § 60.757(f)(4). If any ground level methane concentrations exceed the stated limits the reading must be recorded. *Id.* § 60.757(f)(5).

[165] *Id.* § 63.1980(a).

[166] *See generally* 42 U.S.C. § 7413 (2000).

[167] In the Matter of F.R.&S., 2005 EPA ALJ LEXIS 3 (Jan. 31, 2005) (citing 42 U.S.C. § 7413(d)(1)).

[168] 310 Mass. Code Regs. 7.12(1)–(2) (2006).

[169] 40 C.F.R. § 60.758.

[170] *See, e.g.*, Allied Waste Operating Permit, *supra* note 159, at 9, 10. Noise emissions must also comply with the Massachusetts Department of Environmental Protection's noise guidelines (Policy 90-001) restricting increases in broadband noise levels and production to pure tone noise. Mass. Dep't of Envtl. Prot., Fact Sheet: Noise (2003), *available at* http://www.mass.gov/dep/air/community/noisefs.pdf.

Flares are exempt from the Massachusetts Environmental Policy Act review process where they do not meet the review thresholds for air quality impacts (as set forth in 310 Mass. Code Regs. 7.02(1)), and where open flares do not have the potential to increase emissions more than forty tons per year of VOCs, 100 tons per year of NOx or $SO_2$, twenty-five tons per year of particulates, five tons per year of lead, or 100 tons per year of any combination of hazardous air pollutant.

### C. *Permits for Energy Projects at Brownfields*

#### 1. Air Approvals

If one sites an energy project in a non-attainment area, New Source Review (NSR) applies to air permitting.[171] A "major" source subject to NSR must adopt Lowest Achievable Emission Rate technology.[172] What is "major" ranges by region from ten tons per year in "extreme" non-attainment areas to 100 tons per year in "moderate" areas.[173] In most of the urban areas in the United States, the "major" NSR threshold for ozone precursors is either twenty-five tons per year in "severe" areas such as greater New York City, or fifty tons per year in "serious" non-attainment areas such as Massachusetts.[174] In addition to sizing a LFG-to-energy project to be below the NSR "major" source threshold, there are netting strategies to mitigate this impact.[175]

Conversely, in attainment areas, LFG energy projects or flares that emit less than 2.5 million megagrams, or 2.5 million cubic meters per year of all pollutants, are not subject to review under the federal Prevention of Signification Deterioration program. In Massachusetts, a Best Available Control Technology (BACT) analysis is required by

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[171] 42 U.S.C. § 7502(c)(5).

[172] Steven Ferrey, Environmental Law: Examples and Explanations 173 (3d ed. 2004). This may eliminate turbines since manufacturer guarantees are forty-two parts per million (ppm) and the Best Available Control Technology (BACT) limit is twenty-five ppm for some turbines; micro-turbines claim emissions levels at nine ppm. BACT control usually involves lean-burn combustion with automatic air-to-fuel ratio controls. 40 C.F.R. § 60.332. Manufacturers of internal combustion engines will only guarantee 0.6g per base horsepower hours (bhp-hr) of NOx emissions.

[173] Ferrey, *supra* note 172, at 188.

[174] *Id.* at 187, 188; Massachusetts Department of Environmental Protection, Implementation of the 1990 Federal Clean Air Act Amendments, http://www.mass.gov/dep/air/priorities/1990ca01.htm (last visited Apr. 22, 2007). Emissions from the landfill engines or turbines count toward this potential-to-emit New Source Review (NSR) thresholds, while the flare may or may not count towards the emission threshold.

[175] *See* Ferrey, *supra* note 132, § 6:50.

the Department of Environmental Protection (DEP).[176] Open flares or energy projects which emit more than fifty tons per year of either VOCs or NOx—which are precursors to ozone formation—or 100 tons per year of every other pollutant subject to regulation under the CAA, are subject to be classified in Massachusetts, for example, as a Major Stationary Source, requiring a Non-Attainment Review under 310 Mass. Code Regs. 7.00 Appendix A.[177] A state DEP air quality operating permit can be required.[178]

The air regulators at the state level can condition operating permits by limiting maximum heat input of LFG into flares on a monthly or annual basis, as well as regulating the temperature of flares and the noise from flare operation (measured as increase of decibels).[179] Temperature is controlled within a range to ensure complete combustion of gas constituents. A range of temperature of 1400–2000°F at the exit of the combustion chamber thermocouple is typical.[180]

Despite some obvious advantages, there are additional hurdles to site a renewable wind project on, as opposed to at, a landfill. It is necessary to break through any cap on the landfill and excavate waste to find bedrock below the landfill into which to anchor the turbine mast. This could involve excavating sixty vertical feet or more of waste, and it must be replaced, and the cap repaired, afterward.[181] Breaking through a waste landfill cap requires permission from state regulatory authorities.[182] Once a landfill is closed, a permit is needed to go through any landfill bottom-liner to reach bedrock to secure the turbine pole support.[183] Therefore, an unlined landfill may pose fewer complications.

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[176] No approval of a comprehensive plan approval facility will be issued in instances where the emissions form such a facility or operation of such a facility would not represent BACT. 310 Mass. Code Regs. 7.02(8)(a)(2) (2006).

[177] 310 Mass. Code Regs. 7.00 app. A. Under this regulation, a facility is subject to emission offset and non-attainment review requirements if it is located in an area that is classified as a non-attainment area for any criteria pollutant and is classified as a Major Stationary Source for the pollutant. Such a facility would also be required to meet the Lowest Achievable Emission Rate for each subject pollutant. *Id.*

[178] *See* Mass. Gen. Laws ch. 111, §§ 142B, 142D (2000); 310 Mass. Code Regs. 7.04. LFG open flares qualify as a Fuel Utilization Facility, because they combust LFG, generate heat, and emit the products of combustion, all of which are conditions that satisfy the definition of Fuel Utilization Facility under this regulation. 310 Mass. Code Regs. 7.00.

[179] *See, e.g.*, Allied Waste Operating Permit, *supra* note 159.

[180] *See, e.g.*, *id.*

[181] 310 Mass. Code Regs. 19.130(15)(f), (32) (2005); Manwell, *supra* note 120.

[182] 310 Mass. Code Regs. 19.130(32).

[183] *See id.* at 19.143(1).

2. Zoning Restriction on Reuse

Height is an obvious way to restrict the siting of wind turbines.[184] The Town of Truro sets a 100 foot high limitation on turbines and a set-back requirement of turbine height plus six feet.[185] Truro zoning law prohibits all but the smallest residential-scale turbines.[186] The Town of Orleans sets maximum turbine height at 300 feet.[187] This height restriction contrasts sharply with the Truro height limitation of 100 feet.[188] Local zoning laws that do not expressly address wind turbines often contain low height restrictions that were enacted many years ago, often stemmed from the fact that fire trucks were unable to pump water higher than the specified height of a few stories at the time the zoning bylaw was written.[189] To go higher, a variance must be sought. Strict height restrictions appear to represent the most transparent barrier that a town can erect to prevent wind energy projects.

The zoning laws in Truro require that all persons seeking to construct a wind turbine or wind monitoring tower obtain a special permit.[190] The special permit will only be issued if the project meets detailed design, environmental, and safety standards.[191] Standards for design include limitations on color, completion of a visual impact study, and enclosures for accessory equipment.[192] The Wareham, Massachusetts bylaw allows wind turbines to be constructed on properties of at least five acres with a special permit from the Zoning Board of Appeals.[193]

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[184] *See, e.g.*, Orleans, Mass., Zoning § 164-35.1D(3) (2004); Town of Truro, Mass., Zoning Bylaw § 40.4B(3.1) (2006).

[185] Town of Truro, Mass., Zoning Bylaw § 40.4B(3.1), (3.2) (2006).

[186] *See id.* § 40.4B(3.1); American Wind Energy Association, Wind Web Tutorial: Small Wind Energy Systems, http://www.awea.org/faq/wwt_smallwind.html (last visited Apr. 22, 2007).

[187] Orleans, Mass., Zoning § 164-35.1D(3).

[188] *Id.*; Town of Truro, Mass., Zoning Bylaw § 40.4B(3.1).

[189] American Wind Energy Association, Small Wind Toolbox: Getting a Building Permit, http://www.awea.org/smallwind/toolbox/INSTALL/building_permits.asp (last visited Apr. 22, 2007).

[190] Town of Truro, Mass., Zoning Bylaw § 40.4B(1), (C).

[191] *Id.* § 40.4C.

[192] *Id.* § 40.4C(2).

[193] Warrant, Town of Wareham, Mass., Special Town Meeting art. 37 (Apr. 24, 2006), *available at* http://www.wareham.ma.us/Public_Documents/warehamMA_townmeeting/ (click on "Spring Special 4-24-06" hyperlink). The special permit application process includes various site plans, photographs of the current site with the turbine superimposed over it, landscape plans, and sight-line representations showing the turbine's visibility from nearby property. It requires that the turbine be a neutral color, and prohibits any lighting

The American Wind Energy Association's model zoning ordinance provides no height limitations on wind turbines that are located on property greater than one acre;[194] it restricts tower height to eighty feet on properties between one-half and one acre;[195] and it allows "small wind energy systems," defined as one turbine with a maximum generating capacity of 100 kilowatts, in all zoning districts where "structures of any sort are allowed."[196]

Some towns provide barriers to wind siting when the purpose or scale of the project is of a wholesale or commercial nature. Orleans, Massachusetts' zoning law inhibits development of larger, commercial-scale wind energy projects,[197] classifying commercial and non-commercial wind turbine developments separately.[198] Commercial projects are defined as "those facilities which have less than fifty percent of their electrical output used on site."[199] The law sets out detailed requirements for approval of all projects, but allows the zoning board to exempt non-commercial wind projects from any of the requirements.[200]

### 3. Species Protection

The Massachusetts Natural Heritage and Endangered Species Program reviews all proposed wind energy projects if the property on which the wind turbine will be built is located in a "Priority Habitat" as defined by state regulations.[201] A Priority Habitat is a geographical area

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unless required by Federal Aviation Administration regulations. *Id.* The stated purpose of the bylaw is:

> [T]o encourage by special permit the use of wind energy and to minimize the impacts of wind facilities on the character of neighborhoods, on property values, on the scenic, historic, and environmental resources of the Town; and to protect health and safety, while allowing wind energy technologies to be utilized.

*Id.*

194 American Wind Energy Association, AWEA Model Zoning Ordinance: Permitted Use Regulation for Small Wind Turbines, http://www.awea.org/smallwind/documents/modelzo.html (last visited Apr. 22, 2007).

195 *Id.*

196 *Id.*

197 *See* Orleans, Mass., Zoning § 164-35.1(C)–(D) (2004) (comparing regulation for commercial projects with the ability of a waiver for noncommercial projects.)

198 *Id.*

199 *Id.* § 164-35.1(C).

200 *Id.* § 164-35.1(D).

201 321 Mass. Code Regs. 10.02, 10.18 (2005). It is the responsibility of a person seeking to build a project to determine on their own whether the project property falls within a Priority or Estimated Habitat. Massachusetts Division of Fisheries & Wildlife, Natural Heri-

known to include the habitat of state-listed rare plant and animal species.[202] An Estimated Habitat is an area within a Priority Habitat where state-listed rare wildlife live.[203] As any type of construction in a Protected Habitat could result in a taking of a state-listed species, permission from the Natural Heritage and Endangered Species Program is required before any project can commence.[204]

4. Large Project Approvals

Large wind projects need to be approved prior to construction by the Massachusetts Energy Facilities Siting Board.[205] Even smaller-scale wind projects require approval if the project will require a new transmission line that is over one mile long or rated at over sixty-nine kilovolts.[206] The Board reviews projects with the goal of ensuring a "reliable energy supply for the commonwealth with a minimum impact on the environment at the lowest possible cost."[207]

The Federal Aviation Administration (FAA) also deals with height issues, and requires that persons constructing structures exceeding 200 feet in height submit a "Notice of Proposed Construction or Alteration."[208] This federal requirement resulted in blocking two proposed wind developments on a landfill in the town of Yarmouth, Massachusetts.[209] The town initiated two different proposals to site wind turbines on a town landfill and on the grounds of a public school.[210] The FAA denied both proposals because of the turbines' distance

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tage & Endangered Species Program, Regulatory Review: Priority Habitat and Estimated Habitat for Rare Species, http://www.mass.gov/dfwele/dfw/nhesp/nhenvpriohab.htm (last visited April 22, 2007) [hereinafter Priority Habitat]. An interactive map providing a current list of all Priority and Estimated Habitats is available at http://www.mass.gov/dfwele/dfw/nhesp/nhregmap.htm.

[202] 321 Mass. Code Regs. 10.02.

[203] Priority Habitat, *supra* note 201.

[204] *See* 321 Mass. Code Regs. 10.02; Priority Habitat, *supra* note 201. "Take" is defined as: "in reference to animals to harass, harm, pursue, hunt, shoot, hound, kill, trap, capture, collect, process, disrupt the nesting, breeding, feeding or migratory activity or attempt to engage in any such conduct, or to assist such conduct, and in reference to plants, to collect, pick, kill, transplant, cut or process or attempt to engage or to assist in any such conduct." Mass. Gen. Laws ch. 131A, § 1 (2005).

[205] Mass. Gen. Laws Ann. ch. 164, § 69H (West 2003).

[206] *See id.* §§ 69H, 69G.

[207] *Id.* § 69H.

[208] 14 C.F.R. § 77.13(a)(1) (2006).

[209] *The Town of Barnstable Has Denied the Town of Yarmouth—Again!*, CapeCodToday & The Yarmouth Taxpayer, Dec. 26, 2005, http://www.capecodtoday.com/blogs/index.php/Yarmouth/2005/12/26/barnstable_denies_yarmouth_again.

[210] *Id.*

from the Barnstable Municipal Airport and its resulting potential interference with flight space.[211]

### 5. Historical Protections

The Massachusetts Historical Commission reviews new construction projects that require licenses or permits from a state or federal government agency, regardless of whether the proposed project is on or near a property listed on the National or State Registers of Historic Places.[212] As many wind energy projects can require permits of some sort from at least a state agency,[213] a project would be reviewed by the Commission for compliance with the National Historic Preservation Act of 1966 and equivalent mirror-image state regulation.[214] The review process includes identification of historic properties and the project's effect on them, as well as a determination of how to prevent or minimize any adverse effects.[215]

## IV. Regulatory Incentives

### A. *Renewable Subsidies: System Benefits Charges and Renewable Trust Funds*[216]

The system benefits charge is a tax or surcharge mechanism for collecting funds from electric consumers, the proceeds of which then support a range of activities. In order to support demand-side management (DSM) or renewable resources, funds are collected through a non-bypassable system benefits charge to users of electric distribution services. The money raised from the system benefits charge is then used to "buy down" the cost of power produced from sustainable technologies on both the supply and demand side, so that they can compete with more conventional technologies. More than a dozen states have adopted these programs.

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[211] *See id.*

[212] Massachusetts Historical Commission, Review and Compliance, http://www.sec.state.ma.us/mhc/mhcrevcom/revcomidx.htm (last visited Apr. 22, 2007).

[213] *See* University of Massachusetts at Amherst, Renewable Energy Research Laboratory, Wind Power: Permitting in Your Community, http://www.ceere.org/rerl/publications/published/communityWindFactSheets/RERL_Fact_Sheet_7_Permitting.pdf (last visited Apr. 23, 2007).

[214] 950 Mass. Code Regs. 17.04 (1993); *see* 16 U.S.C. § 470 (2000).

[215] *See, e.g.*, 950 Mass. Code Regs. 17.07.

[216] The following material refers to data available at the conclusion of this Article. *See infra* Appendix, tbl.4.

Between 1998 and 2012, approximately $3.5 billion will be collected by fourteen states with existing renewable energy funds. More than half the amount collected, at least $135 million per year, comes just from California. The funding level taxes range from $0.07 per megawatt-hour (MW-h) in Wisconsin up to almost $0.6 per MW-h in Massachusetts. Most only provide assistance to new projects, and not existing renewable projects.

The form of administration of renewable trust funds varies. Many states administer them through a state agency, while others use a quasi-public business development organization. Some funds are managed by independent third-party organizations, some by existing utilities, while two states allow large customers to self-direct the funds. For distribution, some states utilize an investment model, making loans and equity investments. Other states provide financial incentives for production or grants to stimulate supply-side development. Some other states use research and development grants, technical assistance, education, and demonstration projects.

As Table 4, *infra*, indicates, the funding level is in the range of $175 to $250 million annually for the cumulative impact of the fourteen state system benefit charge programs. While many of these programs are set up to run indefinitely, others have set lifespans. The level of per capita funding ranges between $0.90 to $4.40 annually for renewable energy. Expressed another way, for each MW-h sold in the state, the level of subsidy ranges from $0.07 to $0.59.

### B. *Renewable Resource Portfolio Requirements*[217]

A resource portfolio requirement requires certain electricity sellers and/or buyers to maintain a predetermined percentage of designated clean resources in their wholesale supply mix. A number of variations of resource portfolios are possible, including a renewable resource portfolio requirement, a DSM portfolio requirement, and a fossil plant efficiency portfolio requirement.

Twenty states have adopted the renewable portfolio standard (RPS); two additional states have goals. The key to making the portfolio requirements work is to establish trading schemes for "portfolio obligations." Portfolio standards are flexible in that certain technologies can be included in the renewables definition, or certain subgroups of technologies can be targeted for inclusion at distinct levels. The standard

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[217] The following material refers to data available at the conclusion of this Article. *See infra* Appendix, tbls.5 & 6.

allows market competition to decide how best to achieve these standards. The standards become self-enforcing as a condition of retail sale licensure.

The renewable resource measures that states have incorporated into electricity restructuring and deregulation statutes vary. Some renewable energy measures create portfolio standards; others create trust funds to invest in the development and utilization of renewable resources. Some adopt both concurrently. How each defines an eligible renewable resource varies significantly. Table 5, *infra*, illustrates how states have deployed these two options. Each defines differently what is an eligible renewable resource. The diverse pattern of "renewable" resources included under state definitions is set forth in Table 6, *infra*.

The percent of power that must come from renewables in most RPS state systems escalates on a set schedule each year. For example, in Massachusetts, it began at one percent and increases at an additional one-half percent annually until it reaches four percent of power from new renewable resource in 2009.[218] Against this backdrop there has been from the beginning a shortfall of available renewable energy credits (RECs). The RPS system in Massachusetts, as one example, has not created sufficient RECs to satisfy required regulatory provisions and private sector demand.[219] The alternative compliance cost in Massachusetts for 2006 is approximately 5.5¢ per kilowatt-hour (kW-h) for REC non-compliant projects.[220] This value increases each year with the consumer price index.[221]

Therefore, this shortfall guarantees that RECs will trade in the market at very near the alternative compliance price of more than 5¢ per kW-h, and climb over time. A REC at this value basically doubles the wholesale all-in price of power that renewable energy generators can receive, compared to conventional energy generation sources.[222] In

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[218] 225 Mass. Code Regs. 14.07 (2002).

[219] Commonwealth of Mass., Div. of Energy Res., Renewable Energy Portfolio Standard: Annual RPS Compliance Report for 2004, at 3 (2006), *available at* http://masstech.org/renewableenergy/public_policy.htm (click on "Annual RPS Compliance Report" hyperlink) [hereinafter RPS Compliance Report for 2004].

[220] Commonwealth of Mass., Div. of Energy Res., Massachusetts Renewable Energy Portfolio Standard: Adjustment of the Alternative Compliance Payment (ACP) Rate for Compliance Year 2006 (2006), *available at* http://www.mass.gov/doer/rps/acp06.pdf.

[221] *Id.*

[222] This calculation is based on a typical 5¢ or 6¢ per kilowatt-hour (kW-h) average price for power sales. Associated Indus. of Mass. Found., Massachusetts Renewable Portfolio Standard: Context and Considerations 4 (2004), *available at* http://www.aimnet.org (go to "Business & Economic Information" pull-down menu and follow "Sur-

New England, approximately sixty percent of the RECs generated in 2004 were from LFG projects, with biomass projects generating thirty-five percent, anaerobic digesters four percent and wind and solar about one percent or less each.[223] LFG projects generate more than fifty percent of RPS certificates created in 2005 in Massachusetts.[224]

### C. *Carbon Credits*

Using renewable sources of energy entering service after 2004 creates CO2 credits that can to be traded voluntarily. Members of the Chicago Climate Exchange, which include many leading American companies, have voluntarily committed to reduce their greenhouse gas emissions by one percent per year between 2003 and 2006 against a 1998–2001 baseline.[225] Prices for these voluntary reductions typically traded, as of February, 2007, from three to five dollars per ton.[226] Landfills that are not required by federal law and New Source Performance Standards (NSPS) to collect and combust LFG can qualify for "additionality," and can create Chicago Climate Exchange voluntary greenhouse gas reductions by capturing and utilizing LFG.

The current voluntary greenhouse gas reduction registration process pursuant to section 1605(b) of the Energy Policy Act of 1992 expressly recognizes as creditable carbon reduction attributable to LFG recovery, as well as anaerobic digestion at municipal wastewater treatment plants.[227] If realized and registered now, these reductions are likely to mature into valuable tradable credits when and if the United States adopts a carbon reduction requirement or joins the Kyoto Protocol.

Nine Northeast & Mid-Atlantic states have created the Regional Greenhouse Gas Initiative (RGGI) to limit carbon emitted by large

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veys and Publications" hyperlink; then follow "AIM Foundation Reports" hyperlink; then follow "Renewable Portfolio Standard 10/01/2004" hyperlink).

[223] RPS Compliance Report for 2004, *supra* note 219, at 6.

[224] *See* Commonwealth of Mass., Div. of Energy Res., Massachusetts Renewable Energy Portfolio Standard: Annual RPS Compliance Report for 2005, at 24 (2007), *available at* http://www.mass.gov/doer/rps/rps-2005annual-rpt.pdf.

[225] Chicago Climate Exchange, http://www.chicagoclimatex.com/about/program.html (last visited Apr. 19, 2007).

[226] Chicago Climate Exchange, CCX Carbon Financial Instrument (CFI) Contracts—Market Data, http://www.chicagoclimatex.com/trading/stats/monthly/st_0702.html (Feb. 2007).

[227] *See* Department of Energy, Guidelines for Voluntary Greenhouse Gas Reporting, 71 Fed. Reg. 20,784, 20,799–80 (Apr. 21, 2006) (to be codified at 10 C.F.R. pt. 300).

power plants. LFG projects create tradable carbon offsets.[228] Any projects to create offsets must occur after 2005 and prior to 2009.[229] One is not allowed to register under the RGGI program and other carbon programs simultaneously.[230] Offsets also cannot be awarded for voluntary participation in programs or for elements required by law.[231] If a project is located outside of a participating RGGI state, the sponsor of the offset project can pick any RGGI state in which to file its credits.[232]

Under the RGGI's draft rule, as long as offset credits for carbon were selling for less than seven dollars per ton, carbon reductions created outside the participating RGGI states were discounted by fifty percent to determine their credit value.[233] The final rule eliminated this discount of externally created offsets, but did not change the percent of allowable credits from outside the RGGI area. Under the prior rule, two tons of external carbon reductions created only a single ton of offset credit. Once offsets were trading in the market at greater than seven dollars per ton over a one-year period, credits created from anywhere in North America were valued at full value without any discount,[234] and up to five percent of compliance (as opposed to 3.3% normally) could be satisfied by the purchase and trading of offset credits.[235] Once the market price of offsets increased for a year above ten dollars per ton, offsets could be obtained from anywhere in the United States without any discount, and up to twenty percent of an entity's emissions in year four of the program and after could be obtained utilizing offsets.[236] The purpose of this was to increase the number of available offsets if prices for them rise because of a lack of adequate supply.

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[228] Regional Greenhouse Gas Initiative, About RGGI, http://www.rggi.org/about.htm (last visited Apr. 22, 2007).

[229] Regional Greenhouse Gas Initiative, Regional Greenhouse Gas Initiative Memorandum of Understanding in Brief 2 (2005), *available at* http://www.rggi.org/docs/mou_brief_12_20_05.pdf.

[230] Regional Greenhouse Gas Initiative Model Rule subpt. XX-10.3(d)(4) (2007), *available at* http://www.rggi.org/docs/model_rule_corrected_1_5_07.pdf.

[231] *Id.* subpt. XX-10.3(d)(1).

[232] *Id.* subpt. XX-10.3(g).

[233] Regional Greenhouse Gas Initiative, Regional Greenhouse Gas Initiative—Overview 4–5 (2005), *available at* http://www.rggi.org/docs/mou_rggi_overview_12_20_05.pdf.

[234] *Id.*

[235] Regional Greenhouse Gas Initiative, Frequently Asked Questions 4 (2006), http://ww.rggi.org/docs/faqs_at_draft_mr_release.pdf.

[236] *Id.* at 3–4.

### D. *Net Metering*

Eighty percent of the states have adopted "net metering," a regulatory innovation to implement decentralized renewable power alternatives.[237] While only fifteen states have elected statutory initiatives to implement renewable energy system benefit charges, and thirteen have elected to implement renewable portfolio standards or goals, more than twenty-five states to date are implementing net metering.[238] Through net metering, the retail utility meter runs backwards when a decentralized or renewable energy generator puts power back to the grid. Net metering provides the most significant government policy tool—both qualitatively and quantitatively—to decentralize American power sources.[239]

Net metering can pay the eligible renewable energy source approximately four times more for this power than independent power generators; much more than the time-dependent value of power to the purchasing utility.[240] A 400 percent price advantage over the competition provides a nationwide platform in these thirty-six states to support decentralized energy production.[241]

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[237] "Net metering" or "net billing" is a system that utilizes a single bi-directional meter (or the mathematically netted result of two unidirectional meters) to measure and bill electric energy purchased and sold by a customer. Brief of Respondent-Appellant at 9, MidAmerican Energy Co. v. Iowa Util. Bd., No. 99-1529 (Iowa Ct. App. Aug. 18, 2000). The single meter connects a Qualifying Facility or small power producer directly to an electric utility. *See id.* Net metering allows consumers with small generating facilities (usually photovoltaic solar panels, a fuel cell, or a wind turbine system) to use a single reversible meter to measure the difference between the total electric generation exported to the grid and their total consumption of electricity from the grid. Net metering enables consumer with on-site generation systems to employ any excess electricity that they generate to offset their electric bills. As the consumer's generation system produces electricity, the kilowatts are first used for on-site (sometimes called "station power") needs. Then, if the consumer creates more electricity than needed, the excess generation is fed back into the utility grid and sold back to the utility. Typically, the small producer produces power primarily for his own needs, but when an excess is generated it is sold to the utility and the meter turns backwards. *Id.* Likewise, if the small producer consumes additional power, it may be obtained from the utility through the same meter, turning the meter forward. *Id.* Finally, at the end of the billing cycle, the meter is read and the small producer pays the utility, at the retail rate, for any electricity the utility has supplied to the customer-generator during the bulling cycle.

[238] Steven Ferrey, *Sustainable Energy, Environmental Policy, and States' Rights: Discerning the Energy Future Through the Eye of the Dormant Commerce Clause*, 12 N.Y.U. ENVTL. L.J. 507, 536, 646 (2004).

[239] *See* MARK BOLINGER & RYAN WISER, CLEAN ENERGY FUNDS: AN OVERVIEW OF STATE SUPPORT FOR RENEWABLE ENERGY, at vii (2001), *available at* http://eetd.lbl.gov/ea/EMS/reports/47705.pdf.

[240] *See* Ferrey, *supra* note 12, at 2.

[241] *Id.*

By turning the meter backwards, net metering effectively compensates the generator at the full retail rate for transferring the wholesale energy commodity.[242] While most states compensate the generator for excess generation at the avoided cost or market-determined wholesale rate, as Table 7, *infra*, illustrates, some states compensate the wholesale energy seller for the excess at the fully loaded, and much higher, retail rate.

Electricity is a unique energy form: it cannot be stored or conserved with any efficiency. Therefore, electricity has substantially different value at different hours of the day, different seasons of the year, and at different places in the utility system. Contrary to this physical reality, net metering and billing treats all power at all hours as being tangibly storable or bankable and having equal value, when in fact it does not.

By ignoring interim actual physical transfers of power occurring at all the minutes and hours of the month, and recognizing only the net balance of the transactions at the end of the month or quarter, net metering assumes all electricity generated and transmitted to have equal average value. This is not accurate at the wholesale level, it is not the case with power trading, and it is not the case in those eighteen states where retail competition has been promoted with deregulated competitive retail markets. In deregulated states, wholesale power is differentially valued and priced each hour of each day of the year. It is possible even to "game" the system with net metering—selling power to the utility at the netted average retail price in off-peak late evening hours when the customer/generator has no need for the power and the utility has surplus power. Other utility ratepayers ultimately will be left to make up the revenue deficit that occurs.[243]

Table 7, *infra*, sets forth in representative states the types of technologies eligible for net metering, the types of eligible participating customers, size limits, and what is done with the credit, if any, earned by the customer. Notice that while most states include renewable energy technologies, there is significant variation. Some states do not include municipal solid waste (MSW) trash-to-energy technologies as eligible, because of objection to the burning of municipal trash (as opposed to landfilling or recycling of the trash). States also vary greatly in how large an installation is eligible.

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[242] The following material refers to data available at the conclusion of this Article. *See infra* Appendix, tbl.7.

[243] Ferrey, *supra* note 12, at 120.

How states treat net energy generation (NEG) is one of the more controversial aspects of net metering. NEG is the net surplus of electricity sold to the utility compared to electricity purchased from the utility over a given (typically monthly) billing period. Some states allow any such surplus to be carried over as a credit against the next month. Some limit the duration of this carry-over to a year. At the end of the year, the surplus is either forfeited to the utility, or to low-income energy assistance programs administered by the utility (which effectively pay the utility bill of customers who have not paid). Yet other programs allow the customer to receive cash for the NEG. Collectively, net metering provides the single greatest policy incentive for on-site distributed generation in the United States. Table 7, *infra*, illustrates many of the states' net metering programs and distinctions.

### E. *Financing*

While there are many financing alternatives,[244] landfill brownfields projects can take advantage of special bond financing and tax incentives.

#### 1. Clean Renewable Energy Bonds[245]

Under the federal Clean Renewable Energy Bond (CREB) program, electric cooperatives, public power systems and municipal utilities can issue or benefit from the issuance of clean renewable tax credit bonds (CREBs) to finance renewable energy projects as a less expensive alternative to traditional tax-exempt bonds.[246] The bond authorization is limited to $800 million for the period between January 1, 2006 and December 31, 2007 as allocated by the Secretary of the Treasury Department.[247] The issuer of CREBs receives an allocation from the Secretary of the $800 million available for CREBs.[248] Qualified issuers include:

- A clean renewable energy bond lender;[249]

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[244] *See generally* Ferrey, *supra* note 132, § 3:49–:50.

[245] Part IV.E.1 of this Article is derived from a work previously published by the author. Ferrey, *supra note* 132.

[246] *Id.* § 3:49–:50.

[247] *Id.*

[248] *Id.*

[249] A clean renewable energy bond lender is a lender which is a cooperative owned by, or holding outstanding loans to, 100 or more cooperative electric companies. It must have

- A cooperative electric company;[250] or
- A government body.[251]

A mutual or cooperative electric company or governmental body can borrow CREB proceeds from the qualified issuer.[252] An owner of a CREB is entitled to a tax credit, which is designed to be in lieu of or in substitution for any interest payments on the CREBs.[253] Thus, it is interest-free borrowing. A CREB holder can deduct the amount of the tax credit from total income tax liability, with the proviso that the value of the tax credit is treated as taxable income.[254]

Ninety-five percent or more of the CREB proceeds must be used for capital expenditures by qualified borrowers for qualified projects. "Qualified projects" includes any of the following producing electricity:

- Wind facilities
- Closed-loop or open loop biomass facilities
- Geothermal or solar energy facilities (solar energy facilities must be placed in service before January 1, 2006)
- Small irrigation power facilities.

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been in existence on February 1, 2002, and shall include any affiliated entity which is controlled by such lender.

[250] A cooperative electric company is a mutual or cooperative electric company described in section 501(c)(12) or section 1381(a)(2)(C), or a not-for-profit electric utility which has received a loan or loan guarantee under the Rural Electrification Act.

[251] A governmental body is any state, territory, possession of the United States, the District of Columbia, Indian tribal government and any political subdivision thereof.

[252] A qualified project may be refinanced with proceeds from clean renewable tax credit bonds (CREBs) if the indebtedness being refinanced was incurred by the qualified borrower after the date of enactment of the CREB legislation. CREBs may be used to reimburse a qualified borrower for amounts paid after the date of enactment of the CREB legislation if (1) the qualified borrower declares its intent to reimburse its expenditures with CREBs prior to the payment of the original expenditure, (2) the qualified issuer adopts an official intent to reimburse the original expenditure with CREB proceeds not later than sixty days after payment of the original expenditure, and (3) the reimbursement is made not later than ten months after the date the original expenditure was paid.

[253] A CREB must provide for an equal amount of principal to be paid by the qualified issuer during each calendar year that the CREB issue is outstanding. The issuer must satisfy the "arbitrage" requirements of Section 148 of the Code with respect to the proceeds of a CREB issue, or bonds of such issue will not be considered CREBs. Issuers of CREBs must submit information reports similar to those required by section 149(e) of the Code.

[254] The CREB principal cannot be stripped from the tax credit and the components sold separately.

2. Tax Incentives

The original section 29 tax credit was enacted in 1979 and extended repeatedly thereafter.[255] It currently expires in 2007.[256] For LFG projects, it requires the sale of a "qualified fuel" to an unrelated third party.[257] This tax credit generates cash equivalent to about seventy-five percent of the capital cost of an LFG project during the first ten years of the project.[258] It is a substantial incentive.

In its newer iteration, the old section 29 tax credits, now redesignated as section 45(k) tax credits, provide credits for both direct thermal use of, and electric generation from, LFG.[259] By comparison, the section 45 tax credit applies only to electric generation.[260] While the section 29 credit benefits the owner of the LFG collection system, the section 45 credit benefits the facility producing electricity from LFG.[261] While less generous than the old section 29 credit, it is worth about $350,000 annually for five years for a five megawatt LFG project.[262]

The section 45 credit was originally authorized for wind projects and later expanded to other technologies, and for wind projects is worth approximately 1.8¢ per kW-h for ten years of project operation.[263] This credit is related to the amount of electricity produced and sold to a third party, while by contrast the section 29 credit is earned from the sale of a "qualified fuel" to a third party.[264] These two tax credits cannot be taken simultaneously or "double dipped."[265] These tax credits can be carried back one year or forward up to twenty years for federal income tax purposes.[266]

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[255] Stephen Somerville, PowerPoint Presentation, Section 29 & Section 45 Production Tax Credit Issues for Financiers, Developers & Operators of New and Existing LFG Facilities 8 (Jan. 18, 2006) *available at* http://www.epa.gov/landfill/conf/9th/Presentations/somerville.pdf [hereinafter Somerville Presentation].

[256] Waste Management, PowerPoint Presentation, WM Considerations for LFG Project Development (2005), *available at* http://www.epa.gov/earth1r6/6pd/pd-u-sw/wte_ftworth/landfilltrack/unger.pdf.

[257] Somerville Presentation, *supra* note 255, at 8.

[258] *Id.*

[259] *See id.* at 12.

[260] *See id.* at 8.

[261] *See id.* at 13.

[262] *Id.* at 10–11.

[263] Somerville Presentation, *supra* note 255, at 8, 11.

[264] *Id.* at 8. Questions remain as to whether additional LFG gas supply wells would be eligible for the new section 45 credit, where the existing system and original gas supply wells have already taken the section 29 credit.

[265] *Id.* at 8.

[266] *Id.* at 12.

Also available to some is the Renewable Energy Production Incentive (REPI) to subsidize local and state government owners of renewable energy projects, LFG projects, as well as non-profit electric cooperatives, during the first ten years of LFG project operation.[267] Up to forty percent of the REPI incentive program can be allocated to LFG projects; the remainder goes to other renewable power opportunities, including wind.[268] These payments continue for a ten-year period and are worth approximately 1.5¢ per kW-h, adjusted for inflation after 1993.[269] There are ways to utilize and monetize the private tax credits even for municipal project owners, with careful legal guidance and proper project structuring and contractual relationships. This can also be done to monetize the REPI incentives, through the use of partnerships and LLCs.

## V. The Landfill Brownfields Paradigm Shift

### A. *Economic Hierarchies*

So where does this leave landfill brownfields seven years into the twenty-first century? From a cost-effective energy development perspective, LFG-to-energy development is the first option at a landfill. LFG has an energy content of about 550 BTU per cubic foot, or roughly half the

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[267] Ferrey, *supra* note 132, § 3:53; Stephen Roe et al., E.H. Pechan & Assocs., Inc., Emerging Technologies for the Management & Utilization of Landfill Gas 13 (1998), *available at* http://www.epa.gov/ttn/catc/dir1/etech_pd.pdf (prepared under contract for EPA)[hereinafter Management & Utilization of Landfill Gas]; *see* U.S. Envtl. Prot. Agency, Landfill Methane Outreach Program, PowerPoint Presentation, An Overview of Landfill Gas Energy in the U.S. 23 (Apr. 2006), *available at* http://www.epa.gov/lmop/docs/overview.pdf [hereinafter Landfill Gas Overview]. The Renewable Energy Production Incentive (REPI), created as part of the Energy Policy Act of 1992, provides financial incentive payments for electricity produced and sold by new qualifying renewable energy generation facilities. Management & Utilization of Landfill Gas, *supra.* Eligible electric production facilities are those owned by state and local government entities (such as municipal utilities) and not-for-profit electric cooperatives that have started operations between October 1, 1993 and September 30, 2003. *Id.*

[268] American Public Power Association, Renewable Energy Production Incentive (REPI) Fact Sheet 1, http://www.appanet.org/files/PDFs/REPIFactSheet.pdf (Feb. 2006). Qualifying facilities must use solar, wind, geothermal (with certain restrictions as contained in the rulemaking), or biomass (except for municipal solid waste combustion) generation technologies. Management & Utilization of Landfill Gas, *supra* note 267, at 13.

[269] Management & Utilization of Landfill Gas, *supra* note 267, at 13. Qualifying facilities are eligible for annual incentive payments of 1.5 cents per kW-h (1993 dollars and indexed for inflation) for the first ten-year period of their operation, subject to the availability of annual appropriations in each federal fiscal year of operation. *Id.*

energy density of pipeline quality gas.[270] However, it is still capable at this energy density of running traditional electric-producing turbines or reciprocating engines.

EPA estimates the levelized generating costs of LFG-to-electricity technology as $45.67 per MW-h (4.57¢ per kW-h), which makes LFG electricity less expensive than either wind, geothermal, or solar photovoltaic resources,[271] the other widely used renewable sources, and competitive with fossil fuel generated electricity. For every 1 million tons of MSW in a landfill, under anaerobic conditions, approximately 800 kilowatts of renewable electricity can be produced from the approximately 432,000 cubic feet per day of LFG creation.[272] From the perspective of regulatory fit, LFG makes sense as a brownfield development strategy.[273]

Approximately two thirds of the methane productively captured at landfills is utilized for electricity production, as opposed to direct thermal application.[274] This methane could also be utilized in fuel cells or converted to methanol or ethanol. While the work horse of the LFG-to-electricity industry is reciprocating engines, there are approximately one dozen micro-turbines in operation at LFG facilities.[275]

Landfills actively capturing and utilizing LFG for productive energy purposes tend to congregate in areas where there are extra incen-

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[270] ENERGY INFO. ADMIN., U.S DEPT. OF ENERGY, RENEWABLE ENERGY ANNUAL 10 (2002), *available at* http://tonto.eia.doe.gov/FTPROOT/renewables/060302.pdf.

[271] *See* Landfill Gas Overview, *supra* note 267, at 10. Solar PV projects have been sited on brownfields. A 400Kw PV installation was constructed in Brockton, Massachusetts at a former manufactured gas plant on ten acres capped at this site. This was a $3 million project. *See* Press Release, Renewable Energy Trust, Nation's Largest "Brightfield" Dedicated in Brockton, Massachusetts (Oct. 26, 2006), *available at* http://www.renewableenergyaccess.com/rea/partner/story?id=46601.

[272] *See* Landfill Gas Overview, *supra* note 267, at 5. If not collected and controlled, this LFG escapes as fugitive emissions from the landfill and contributes both to smog and global warming. *Id.*

[273] Wind receives a production tax credit that is significant. *See* JANET E. MILNE, TAX INCENTIVES FOR WIND POWER & THE SALE OF LANDFILL GAS 2 (2004), *available at* http://www.abanet.org/rppt/meetings_cle/joint2004/Handouts/JointPrograms/GeneratingPowerFromWindandLandfills/TaxIncentivesforWindPowerandLandfillGas.pdf.

[274] U.S. Environmental Protection Agency, Landfill Methane Outreach Program, http://www.epa.gov/lmop/overview.htm (Apr. 4, 2007). "Of the 5.9 million metric tons of methane believed to be captured from [U.S. landfills] in 2002, 3.0 million metric tons was recovered for energy use, and 2.9 million metric tons was recovered and flared." Energy Information Adminstration, Methane Emissions http://www.eia.doe.gov/oiaf/1605/gg03rpt/methane.html (Apr. 29, 2004).

[275] Jennifer Weeks, *Landfills Expand Energy Output*, BIOCYCLE, Aug. 2005, at 53, *available at* http://www.jgpress.com/archives/_free/000507.html ("Approximately a dozen microturbine LFG facilities are currently in operation.").

tives, such as renewable portfolio standards (RPSs).[276] All states that have adopted an RPS system have elected, as a matter of state law, to recognize LFG as an eligible "renewable" fuel.[277] Landfill gas is eligible as a "green" energy source in those thirty states that allow green power marketing and commands a price premium ranging from 0.5¢ to 5¢ per kW-h.[278] In addition, LFG projects placed in service by 2006, under current legislation, unless and until it is extended or renewed, receive a section 45 tax credit of 1¢ per kW-h during their first five years of operation.[279] These tax credits historically have been extended in subsequent legislation. LFG projects are economically viable, environmentally positive, and add to the inventory of non-greenhouse-gas-producing energy sources.

### B. *Reconfiguring Landfill Land Uses*

In an era of high world oil and gas prices, access to non-curtailable, reliable energy sources is a key advantage. With the rising cost of natural gas,[280] landfills that can produce and deliver LFG and/or power become attractive sites for industries or commercial facilities that need reliable and/or low-cost natural gas or methane supply. Such facilities would normally not think about locating at a landfill, but for these rising energy prices.

The bulk of landfills in the country are municipally owned.[281] Moreover, since the private sector has already developed LFG projects at many larger private sites, the majority of remaining best-candidate LFG-to-energy projects are at municipally owned landfills.[282] This

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[276] *See supra* Part IV.B.

[277] *See infra* Appendix, tbl.6.

[278] *See* Ferrey, *supra* note 132, § 10:98.

[279] U.S. Environmental Protection Agency, Landfill Methane Outreach Program, Summary: Energy Policy Act of 2005, http://www.epa.gov/lmop/docs/engy_pol.pdf (last visited Apr. 22, 2007).

[280] Justin Blum, *Natural Gas's Danger Signs*, Wash. Post, Oct. 7, 2005, at D-1.

[281] U.S. Envtl. Prot. Agency, EPA-821-B-99-005, Economic Analysis of Final Effluent Limitations Guidelines and Standards for the Landfills Point Source Category 3-7 (1999), *available at* http://www.epa.gov/waterscience/guide/landfills/final/economics.pdf.

[282] U.S. Environmental Protection Agency, LMOP: Landfill Database: Operational LFG Energy Projects, *available at* http://www.epa.gov/lmop (follow "Energy Projects & Candidate Landfills" hyperlink; then follow "Operational LFG energy projects, sorted by state and landfill name" hyperlink) (last visited Apr. 22, 2007); U.S. Environmental Protection Agency, LMOP: Landfill Database: Candidate Landfills, *available at* http://www.epa.gov/lmop (follow "Energy Projects & Candidate Landfills" hyperlink; then follow "Candidate Landfills, sorted by state and landfill name" hyperlink) (last visited Apr. 22, 2007).

makes for many smaller landfill projects at sites owned by municipal entities—which traditionally have not collected LFG and are not familiar with LFG-to-electricity projects—prime candidates for application of this technology. Even a very small municipal project can yield net revenues to the municipality of $250,000 annually or more.

It is axiomatic to note that not all landfills are created equal. Some are better candidates than others for energy development. Like many things in life, this is a function of physical and longevity factors related to carbon-based molecules.

Key landfill development parameters include landfill size, years since closure, the type of waste accepted, and whether an LFG collection and control system is in place. Any landfills that accepted large quantities of ash, demolition, stump, sludge or soil offer less in terms of potential LFG generation.[283] Larger sized landfills produce more LFG, since they have a larger waste mass. LFG production decreases annually after closure, therefore producing less LFG in older landfills.[284] Any landfill with at least twenty to twenty-five acres or more and approaching approximately 1 million tons of MSW waste, closed in the past decade, offers potential.[285]

Not all regulatory environments are created equal. The economic incentives for turning the organic content of waste into energy are greatest in Massachusetts and similarly disposed states for a variety of reasons: Massachusetts has the highest tipping fees for landfills in the United States,[286] some of the highest electricity prices,[287] and some of the highest natural gas prices. Of the approximately 701 inactive and closed landfills in Massachusetts, sixteen landfills have been developed with some type of LFG-to-energy project.[288]

From a perspective of what energy source to develop first at a landfill, an LFG capture program should take priority for evaluation.

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[283] These waste types tend to contain large amounts of inert materials that do not produce methane.

[284] U.S. Envtl. Prot. Agency, EPA-453/R-94-021, Air Emissions from Municipal Solid Waste Landfills—Background Information for Final Standards and Guidelines (1995), *available at* http://www.epa.gov/ttn/atw/landfill/bidfl.pdf.

[285] These figures reflect the author's own calculations from development experience. Waste in place totals are not available for all landfills. Landfill acreage can be used to estimate volume.

[286] The tipping fees for landfills in Massachusetts average $72.60 per ton, the highest in the United States. Kaufman et al., *supra* note 11, at 38 tbl.7. The average U.S. tipping fee at waste-to-energy combustion facilities is $62.07 per ton. *Id.*

[287] NSTAR Boston Edison's residential prices in 2006 were approximately 20¢ per kW-h.

[288] Mass. Dep't of Envtl. Prot., Inactive or Closed Solid Waste Landfills in Massachusetts 89 (2006), *available at* http://www.mass.gov/dep/recycle/inactlf.pdf.

Methane destruction has been a prime target of the campaign against global warming, because as a greenhouse gas methane is deemed to have twenty-one times the impact, molecule-by-molecule, compared to $CO_2$.[289] When utilized productively, LFG is considered a carbon-neutral fuel, since its combustion releases carbon that was recently sequestered by the organic source materials before being placed in the landfill; those source materials, when degrading anaerobically, generate and release their methane content.[290]

## VI. Brownfield Liability for the Hazardous Cocktail

### A. *The CERCLA Scheme for Operator Liability*

Operators of contaminated sites inherit legal liability, jointly and severally, for their cleanup under both federal Superfund and many state environmental statutes. The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) imposes a strict, joint and several liability for clean-up costs incurred as a result of releases or threats of release of hazardous substances on four categories of responsible parties: (1) owners and operators of a facility from which hazardous substances were threatened to be released or actually released; (2) persons who owned or operated a facility at the time of hazardous substance disposal; (3) persons who arranged for disposal of hazardous substances; and (4) persons who transported hazardous substances and selected the disposal sites.[291] Both government and private parties can recover response costs[292] which they have incurred.[293]

Although the final version of CERCLA deleted all reference to joint and several liability,[294] courts have held that potentially responsible party (PRP) liability is joint and several if no basis exists for dividing

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[289] Ferrey & Cabraal, *supra* note 89, 9 tbls.1 & 2.

[290] Weeks, *supra* note 275, at 51.

[291] *See* 42 U.S.C. § 9607(a) (2000 & Supp. IV 2004).

[292] Response costs are those costs associated with removal and remediation actions at the waste site. *Id.* § 9601(25).

[293] *Id.* § 9607(a)(4)(A)–(D). The plaintiffs can impose liability on potentially responsible parties (PRPs) by bringing claims under section 107 of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), which provides for the recovery of: (A) all costs of removal and remedial action incurred by the United States Government or a State or an Indian tribe not inconsistent with the national contingency plan; and (B) any other necessary costs of response incurred by any other person consistent with the national contingency plan. *Id.*

[294] *See* Colorado v. ASARCO, Inc., 608 F. Supp. 1484, 1486 (D. Colo. 1985) ("It is clear, however, that the deletion of all references to joint and several liability from [CERCLA] did not signify that Congress rejected these standards of liability.").

the harm of the contamination and the response costs.[295] In addition, CERCLA incorporates by reference section 311 of the Clean Water Act,[296] where case law thereunder holds violators strictly liable for damages.[297] Courts have interpreted this provision as allowing plaintiffs to recover all costs of remediation jointly and severally against these defined categories of responsible parties.[298]

Correspondingly, courts overwhelmingly hold parties strictly liable for cost recovery actions under CERCLA section 107, regardless of negligence by owners, operators, or others.[299] According to these decisions, the plaintiffs (often the government) can entirely shift the cost burden to any one or more of the PRPs,[300] who could bear the financial cleanup burden in its entirety. Plaintiffs who bring suit under section 107 of CERCLA therefore are not required to link their response costs with specific releases or activities of particular defendant PRPs.[301] Courts also hold that a showing of proximate cause is

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[295] *See* Amoco Oil Co. v. Borden, Inc., 889 F.2d 664, 672 (5th Cir. 1989); United States v. Monsanto Co., 858 F.2d 160, 169–70 (4th Cir. 1988); *ASARCO, Inc.*, 608 F. Supp. at 1486. Courts have used different standards when determining whether or not a basis of divisibility exists. *See, e.g.*, *In re* Bell Petroleum Servs., Inc., 3 F.3d 889, 903 (5th Cir. 1993) (holding that joint and several liability should be imposed only in "exceptional circumstances" unless the "expert testimony and other evidence establishes a factual basis for making a reasonable estimate that will fairly apportion liability," and that the court should not be dissuaded from dividing liability just because apportionment is difficult to determine with certainty).

[296] 42 U.S.C. § 9601(32) (2000 & Supp. IV 2004) (providing that liability under CERCLA shall be construed as the standard of liability under title 33, section 1321).

[297] *See, e.g.*, United States v. Chem-Dyne Corp., 572 F. Supp. 802, 806–08 (S.D. Ohio 1983); *see also* FERREY, *supra* note 172, at 359–60. As Senator Randolph explained, "Unless otherwise provided for in this act, the standard of liability is intended to be the same as that provided in section 311 of the Federal Water Pollution Control Act (33 U.S.C. § 1321). I understand this to be a standard of strict liability." *Chem-Dyne Corp.,* 572 F. Supp. at 806–08 (citing 126 Cong. Rec. S14964 (Nov. 24, 1980)).

[298] *See, e.g.*, *Chem-Dyne Corp.*, 572 F. Supp. at 804–08 (stating that where the harm is indivisible, each liable party is responsible for the entire harm).

[299] *See Monsanto*, 858 F.2d at 167–68 (observing and following "the overwhelming body of precedent that has interpreted section 107(a) as establishing a strict liability scheme"). Moreover, liability applies retroactively to actions which occurred prior to the enactment of CERCLA. *See, e.g.,* United States v. Ne. Pharm. & Chem. Co., 579 F. Supp. 823, 839, 844 (W.D. Mo. 1984) *aff'd in part, rev'd in part on other grounds,* 810 F.2d 726, (8th Cir. 1986) (stating that section 107(a) was intended to apply retroactively to off-site generators, which can be held strictly liable).

[300] *See Monsanto*, 858 F.2d at 168 ("Under section 107(a)(2), *any* person who owned a facility at a time when hazardous substances were deposited there may be held liable for all costs of removal or remedial action."); *Ne. Pharm. & Chem. Co.*, 579 F. Supp. at 844.

[301] *See* Violet v. Picillo, 648 F. Supp. 1283, 1292 (D.R.I. 1986) (stating that with regard to the harm caused by the release of waste at a particular site, "CERCLA only requires that the plaintiff prove . . . that the defendant deposited his hazardous waste at the site and that

not required before liability may be imposed on current or former owners or operators of disposal sites.[302]

Thus, plaintiffs establish the requisite causation against an operator of a business at a contaminated site where there are hazardous substances once they show that: the defendant is an operator of a facility where there was a release or threatened release of hazardous substances, and that it caused the incurrence of response costs.[303] Unless defendant parties can avail themselves of one of the extremely limited defenses provided by the statute,[304] or equitable defenses developed at common law, such as laches,[305] estoppel,[306] or unclean hands, which typically are not countenanced in section 107 actions,[307] liability is joint, several, and strict.[308] Furthermore, when a municipality, country, or

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the hazardous substances contained in the defendant's waste are also found at the site"); *see also* Colorado v. Idarado Mining Co., 707 F. Supp. 1227, 1232, 1243 (D. Colo. 1989), *rev'd on other grounds,* 916 F.2d 1486 (10th Cir. 1990) (stating that the state is not required to "fingerprint" the defendant's wastes in order to establish liability under CERCLA).

[302] *See* Pennsylvania v. Union Gas Co., 491 U.S. 1, 53 n.5 (1989) (asserting that states can also be held strictly liable under CERCLA); New York v. Shore Realty Corp., 759 F.2d 1032, 1044 (2d Cir. 1985); *see also* United States v. Price, 523 F. Supp. 1055, 1073–74 (D.N.J. 1981) (holding subsequent landowners liable merely by virtue of "studied indifference" to hazardous condition), *aff'd*, 688 F.2d 204 (3d Cir. 1982).

[303] *See* United States v. S.C. Recycling & Disposal Inc., 653 F. Supp. 984, 993 (D.S.C. 1984), *aff'd sub nom.* United States v. Monsanto Co., 858 F.2d 160, 167 (4th Cir. 1988). However, proximate cause must be shown to impose liability on transporters of hazardous substances, whom both the statute and case law link to clean-up costs only if the transporters selected the disposal site. 42 U.S.C. § 9607(a)(4) (2000 & Supp. IV 2004); *see* United States v. Conservation Chem. Co., 619 F. Supp. 162, 191 (W.D. Mo. 1985).

[304] *See* 42 U.S.C. § 9607(b) (2000 & Supp. IV 2004). These defenses are available when releases of hazardous materials are caused by (1) acts of God, (2) acts of war, or (3) acts or omissions of unrelated third parties with whom a PRP has direct or indirect contractual link, where the PRP exercises due care with respect to any hazardous substances and where the PRP took precautions against foreseeable acts or omissions of any such third party. *See id.*

[305] A few courts find laches is a possible defense to a section 107(a) suit, which is essentially an equitable claim seeking reimbursement for monies spent. *See Conservation Chem. Co.*, 619 F. Supp. at 206. *But see* United States v. Mottolo, 605 F. Supp. 898, 909 (D.N.H. 1985) (finding that doctrine of laches would not bar the government from suing in its sovereign capacity for reimbursement of remedial and response costs under CERCLA).

[306] Although the equitable defense of estoppel has not been reviewed by the courts in CERCLA cases, the district court in *Conservation Chem. Co.* stated in dictum that estoppel would be an appropriate defense in section 107 actions. 619 F. Supp. at 206.

[307] *See id.*; Mardan Corp. v. C.G.C. Music, Ltd., 600 F. Supp. 1049, 1057–58 (D. Ariz. 1984) (finding unclean hands applicable in a private party response recovery action under CERCLA), *aff'd* 804 F.2d 1465 (9th Cir. 1986).

[308] One possible, though limited, defense includes a lack of authorization for national service. *See, e.g., In re* Acushnet River & New Bedford Harbor Proceeding re Alleged PCB Pollution, 675 F. Supp. 22, 29 & n.7 (D. Mass. 1987); Wehner v. Syntex Agribusiness, Inc. 616 F. Supp. 27, 28 (E.D. Mo. 1985). *But see* United States v. Bliss, 108 F.R.D. 127, 134–35

state agency owns or operates the disposal site, CERCLA treats the entity like a private person.[309] "Operation" is generally deemed to involve "control" of the site.[310]

Therefore, in operating an energy project at a landfill site wholly unrelated to the deposition or management of solid waste, such as an LFG-to-energy, biomass, wind, or other renewable energy project, a private energy project operator can inherit under applicable law liability for the entire cleanup of the landfill contamination problem. While this may seem grossly unfair, this is the way the law has been drafted and interpreted.

While prosecutorial discretion under Superfund is delegated to EPA, this does not necessarily solve the problem. EPA has the discretion to prosecute one, another, some, or all, of the PRPs at a landfill site contaminated by hazardous substances, including otherwise "innocent" operators of the facility.[311] It is much easier for a plaintiff to prove damages against a lesser number of defendants; if section 107 is employed, only a single defendant need be named to shift potentially the entire liability to the named defendants.[312] This is much easier than bearing the burden of proof severally against every PRP.

Municipalities may be liable just as any other "person," under CERCLA section 107,[313] as owners or operators of disposal sites or as persons who arranged for disposal of hazardous substances. For instance, in the seminal case of *B.F. Goodrich Co. v. Murtha*,[314] PRPs

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(E.D. Mo. 1985) (finding that CERCLA authorizes nationwide service of process for abatement actions under section 106). Another possible defense is unjust enrichment to prevent a landowner from obtaining contribution or indemnification. *Cf.* Gould v. American-Hawaiian Steamship Co., 387 F. Supp. 163, 170–71 (D. Del. 1974), *vacated on other grounds*, 535 F.2d 761 (3rd Cir. 1976) (denying contribution in a federal securities action on unjust enrichment grounds). A possible final defense is the statute of limitations. 42 U.S.C. § 9612(d) (2000 & Supp. IV 2004).

[309] 42 U.S.C. § 9601(21); *see* Artesian Water Co. v. Gov't of New Castle County, 605 F. Supp. 1348, 1354–55 (D. Del. 1985) (finding that Congress did not intend to differentiate between governmental and nongovernmental entities for purposes of CERCLA liability); *see also* Ferrey, *supra* note 66, at 232.

[310] 42 U.S.C. § 9607(a).

[311] Ferrey, *supra* note 172, at 367.

[312] *See id.* at 234–35.

[313] *See* 42 U.S.C. § 9607.

[314] 958 F.2d 1192, 1196–99 (2d Cir. 1992). In turn, the defendant landfill owner filed third-party claims for contribution and indemnification from various municipalities. Therefore, the PRP complaints were amended to add the municipalities as defendants in the original action. The court of appeals held that CERCLA does impose liability on a municipality that arranges for disposal or treatment of municipal solid waste that contains a hazardous substance, even though such solid waste contains primarily household solid

brought an action against owners and operators of a landfill to recover past and future clean-up costs under CERCLA.

In fact, EPA has shown a predilection to *not* prosecute municipalities for solid waste problems, and instead to prosecute private parties that might have some association with the landfill.[315] Where municipalities are found liable, there are provisions at third-party landfills for municipalities to pay a diminished share of liability.[316] In response to litigation, EPA stated in a written stipulation that its municipal settlement policy is not a rule and has no binding force or effect.[317] Yet, energy project operators at landfills still could end up with legal liability not of their making.

## B. *Legal Mitigation Strategies*

Potential private landfill developers have shied away from projects at or involving existing solid waste facilities, because their counsel have advised them that the risks of derivative legal liability, jointly and severally, at the site exceed the benefits of the development.[318] Conventional statutory and equitable protections in most cases do not address these issues. For example, while CERCLA contains relatively recent amendments under federal law that exempt "innocent owners,"[319] these do not include "innocent operators,"[320] although some

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waste. Second, CERCLA's definition of hazardous substance makes no distinction based on whether the substance's source was industrial, commercial, municipal or household.

[315] *See id.*

[316] In 1997, EPA implemented a new method to allocate responsibility at waste sites that contain both municipal waste and hazardous waste. EPA adopted a formula to charge municipalities less. EPA now multiplies the known quantity of municipal solid waste contributed by a PRP, by an estimated unit cost for remediating municipal solid waste at a typical representative municipal solid waste-only landfill. This estimated cost is derived from data on clean, non-problem municipal solid waste-only landfills that are not subject to CERCLA response actions or RCRA corrective action. Of course, CERCLA hazardous waste sites, in fact, are not model or typical clean municipal waste landfills. Where the municipality is the owner of the hazardous waste landfill, the EPA uses a twenty percent baseline share to reflect response cost liability. Announcement and Publication of the Policy for Municipality and Municipal Solid Waste; CERCLA Settlements at NPL Co-Disposal Sites, 63 Fed. Reg. 8197, 8199 (Feb. 18, 1998).

[317] Subsequent litigation was filed contesting the policy. EPA sought dismissal on the basis that should EPA choose to apply this policy, appropriate court review would be of the settlement reached in such a specific instance. The court dismissed this challenge as not contesting "final agency action" of a policy ripe for judicial review and therefore not reviewable under the Administrative Procedure Act. Chemical Mfrs. Ass'n v. EPA, 26 F. Supp. 2d 180, 182 (D.D.C. 1998).

[318] This assertion is derived from the experience of the author in counseling various energy market participants.

[319] 42 U.S.C. § 9601(35)(A) (2000 & Supp. IV 2004).

courts could interpret this provision to extend to "operators."[321] Therefore, it is conceivable that as a matter of federal law an owner of a waste landfill could be "innocent," while the "operator" of the energy facility at a landfill could become a prime target for liability associated with prior disposal of solid waste.[322]

This anomaly calls for special legal protections to be invoked. For a number of years, EPA issued so-called "comfort letters," to memorialize an enforcement position regarding liability for subsequent owners or operators of previously contaminated sites.[323] These EPA comfort letters can take four forms.

First, a comfort letter can indicate "no previous federal Superfund interest." This indicates that there has been no previous federal involvement with hazardous substance remediation at a particular site, but makes no promises as to the future.[324] The second type of comfort letter is a "no current federal Superfund interest" letter, discretionarily issued where a site has been sufficiently addressed or remediated, and is no longer the target it once was for possible federal involvement to compel remediation.[325] The third type of comfort letter is a "federal interest" letter, which merely informs the recipient that EPA is interested in addressing the site as a matter of federal law enforcement and provides a current status report. The fourth type of comfort letter is a "state action letter," which indicates that the state is taking the lead on cleanup oversight.[326]

While such letters may provide some "comfort," they do not provide any legal guarantee that EPA will not take a later enforcement action against unrelated parties who operate subsequent energy facilities. Therefore, they are an unenforceable "handshake," limited by

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[320] *See id.*

[321] *See id.* § 9607(a), (b)(3).

[322] *See* Memorandum from Susan E. Bromm, Dir., EPA Office of Site Remediation Enforcement, to EPA Dirs., Interim Guidance Regarding Criteria Landowners Must Meet in Order to Quality for Bona Fide Prospective Purchaser, Contiguous Property Owner, or Innocent Landowner Limitations on CERCLA Liability (Mar. 6, 2003), *available at* http://www.epa.gov/compliance/resources/policies/cleanup/superfund/common-elem-guide.pdf.

[323] *See* Sample Letters from Steven A. Herman, EPA Office of Enforcement and Compliance Assurance, Policy on the Issuance of Comfort/Status, (n.d.) (on file with author); *see also* Policy on the Issuance of Comfort/Status Letters, 62 Fed. Reg. 4624, 4624 (Jan. 30, 1997).

[324] *See* Policy on the Issuance of Comfort/Status Letters, 62 Fed. Reg. at 4625.

[325] *See, e.g.*, *id.*

[326] *Id.* A state can participate as the lead agency under separate cooperative agreement between the state and regional EPA office or under a memorandum of agreement.

time, rather than a legal guarantee.[327] Comfort letters may be modified to include a covenant-not-to-sue, which releases the new "operator" from liability for cleanup of pre-existing contamination.[328] However, absent such language of release, the comfort letter does not really offer any significant protection, other than an indication of current thinking of the enforcement agency.

Under the relatively recent "*bona fide* purchaser"[329] amendments to Superfund, which can allow a subsequent purchaser of real property to take title knowing of pre-existing contamination, and still not inherit clean-up liability under certain conditions, subject to certain "windfall" federal liens,[330] EPA has recently been issuing fewer "comfort letters." However, neither the "innocent owner" nor "*bona fide* purchaser" amendments to the federal CERCLA statute relieve the liability of an innocent "operator" operating an energy facility at an existing landfill owned by another private or municipal entity.[331] Therefore, those third parties who would operate an energy facility at a landfill are left to fall between the legal cracks of existing Superfund statute and agency policy. This is a significant gap that has worked as a serious discouragement to third parties tapping the existing landfill energy potential across the nation. As a consequence, rational national energy goals have suffered.

Many states, such as Massachusetts, also can execute covenants-not-to-sue. These typically are negotiated with the state attorney general, are subject to discretion in crafting terms, and require public comment before execution.[332] These state covenants, however, can be negotiated with operators as well as owners. The state's attorney general will bargain for a certain level of site remediation prior to granting the covenant and must determine that the proposed development would not proceed but for the covenant.[333] Often, a showing that liability relief is not otherwise available, and that the site would not oth-

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[327] *See, e.g.*, *id.* at 4624.

[328] *See, e.g.*, *id.*

[329] 42 U.S.C. § 9601 (40) (2000 & Supp. IV 2004).

[330] *Id.* § 9607(r).

[331] *See id.* § 9607(q)(1)(C).

[332] *See, e.g.*, Mass. Gen. Laws ch. 21E, § 3A(j)(3)(2004); 940 Mass. Code Regs. 23.00-23.09 (2004). The Massachusetts covenant not to sue was enacted pursuant to the Brownfields Act of 1998, Chapter 206 of the Acts of 1998. They often require as a prerequisite that the site achieve a certain degree of remediation, and typically only exempt recipients of these letters from *preexisting* contamination liability.

[333] 940 Mass. Code Regs. 23.03(1)(g); *see* Mass. Gen. Laws ch. 21E, § 3A(j).

erwise be developed for an energy-related brownfield purpose, is necessary.[334]

These covenants can be critical to energy project development. Otherwise, the liability uncertainties and impediments, which notably are a creation solely of law and not of any technical impediments, can swamp the energy revenue and environmental benefits perceived by third parties to develop energy projects at landfill sites. The joint and several liability risk of the Superfund statute often bludgeons the economic incentives and environmental benefits that many well-meaning parties and entrepreneurs would otherwise attempt to realize at these sites. It is the legal issues which create the most profound disincentives to landfills' productive reuse and development. These same issues have received by far the least attention, judging by the literature regarding landfills and EPA funding initiatives.

## Conclusion

There are ways to bridge these chasms utilizing creative legal techniques. Before more of the tens of thousands of existing municipal landfills become too aged to support landfill gas-to-energy projects—and in the interest of methane containment and mitigation, renewable energy development goals, and energy efficiency—there should be greater effort redirected to providing the legal templates to insulate new energy project operators from preexisting legal liability at brownfields/landfills. Temporarily, we can adopt more aggressive agreements embodying legal covenants not to sue third party energy project operators. Longer term, state and federal statutes must distinguish between environmental negatives and energy positives in sculpting a more discerning division among liable and non-liable parties.

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[334] 940 Mass. Code Regs. 23.03(1). One particular advantage of the covenant is that it can protect not only against liability to the state, but also against third-party claims for contribution, response costs, and property damage under both statutory and common law. State claims are relieved once a permanent remedy or Remedy Operation Status (ROS) is achieved. Parties who receive ninety days notice are allowed to join the agreement. *Id.* at 23.06. To obtain this covenant, one must demonstrate that the benefits of this project create new permanent jobs and/or provide some other public benefit. *Id.* at 23.03. There must be a substantial likelihood that the project would not occur without the covenant. There also are funds available as loan or grant (with twenty percent owner matching) up to $50,000 for site assessments and up to $500,000 for site remediation. MassDevelopment, Financing: Brownfields Redevelopment Fund, http://www.massdevelopment.com/financing/lg_brownfields.aspx (last visited Apr. 22, 2007). There also is a brownfield tax credit worth twenty-five percent of remediation costs upon completion of clean-up. Mass. Gen. Laws ch. 63, § 38Q.

Creative legal reforms, not technical seminars, are the most urgently needed changes in this market. This can be a win-win situation for municipalities, the public, and state and federal enforcement agencies across the United States.

When covenants not to sue are in place, the critical joint and several liability risks associated with prior conditions are mitigated. This is one essential change to accomplish in order to make development possible at brownfields landfills. For private sector developers, these legal risks subsume the development opportunities.

A second essential factor is to cause municipal landfill owners to change their landfills paradigm. Most municipalities view their landfills as environmental negatives that must be hidden or ignored. They raise issues of contamination and liability. In fact, these landfills can be opportunities, at best, to capture landfill gas as an energy source, and at least to control landfill methane to mitigate global warming. There are opportunities both to utilize this methane, as well as to utilize the land area of existing landfills for wind or biomass facility siting.

The regulatory environment provides significant incentives for such renewable energy developments. Tax credits, tax-preferenced Clean Renewable Energy Bonds, and renewable energy credits under state renewable portfolio standard laws in twenty-two states, as well as direct renewable trust fund subsidies in sixteen states, provide significant financial incentives for such renewable energy developments. Net metering also is available in forty states. Combined, these incentives should compel a much more vigorous development of energy generation potential at those brownfields that are existing landfills. Collectively, these factors create a new and different landfill paradigm, viewed through the lens of renewable energy potential, not just waste and contamination.

# Appendix

TABLE 1: Comparison of Residential Waste Composition in the State of California (Weight Percent)

| | North Santa Clara County | | | | | Santa Cruz Co.[1] | Rich-mond[2] | San Diego[3] | Santa Monica[4] |
|---|---|---|---|---|---|---|---|---|---|
| | **Sum.** | **Autumn** | **Winter** | **Spring** | **Sum.** | **Winter** | **Spring** | **Spring** | **Summer** |
| Component | 1979 | 1982 | 1983 | 1983 | 1983 | 1983 | 1982 | 1981 | 1980 |
| Mixed Paper | 15.6 | 20.2 | 19.9 | 14.1 | 12.5 | 15.8 | 30.6 | 25.4 | 11.1 |
| Newspaper | 14.0 | 10.1 | 12.2 | 14.6 | 15.3 | 8.7 | 9.0 | 9.1 | 12.3 |
| Corrugated | 10.6 | 18.0 | 16.1 | 12.9 | 12.7 | 14.6 | 11.7 | 5.5 | 18.2 |
| Plastic | 4.7 | 9.6 | 5.6 | 5.7 | 5.6 | 9.4 | 6.2 | 6.5 | 7.7 |
| Yard Waste | 26.9 | 26.5 | 20.8 | 24.2 | 31.6 | 9.8 | 13.7 | 22.6 | 16.7 |
| Food Waste | 4.4 | 3.1 | 8.5 | 6.5 | 4.1 | 13.6 | NM | NM | 7.6 |
| Other Organic | 6.4 | 2.3 | 1.6 | 5.4 | 5.0 | 9.4 | 4.8 | 15.9 | 6.8 |
| Ferrous | 6.0 | 3.4 | 2.9 | 4.1 | 3.1 | 5.1 | 5.3 | 4.0 | 5.6 |
| Aluminum | 0.7 | 0.9 | 1.3 | 0.9 | 0.6 | 1.3 | 1.2 | 1.0 | 1.0 |
| Glass | 10.6 | 4.4 | 8.2 | 9.8 | 8.5 | 9.7 | 14.6 | 8.8 | 12.2 |
| Other Inorganic | 0.1 | 1.5 | 2.9 | 1.8 | 1.0 | 2.6 | 2.9 | 1.2 | 0.8 |
| Total | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |

[1] Reference 10.
[2] Reference 9.
[3] Reference 11.
[4] Reference 12.
NM = Not Measured.
**Source:** Cal. Recovery Systems, Inc., North Santa Clara County Comprehensive Waste Characterization Study (1982-83) T. IV-3, at 24 (1984).

TABLE 2: Comparison of Elemental Analyses of Organic Fraction of Municipal Solid Waste (MSW)
(Oven-Dry Basis)

| Element | North Santa Clara County* | San Diego | Ame RDF |
|---|---|---|---|
| Aluminum | 3700 | | 13,600 |
| Antimony | < 70 | 3 | 25 |
| Arsenic | 7 | 10 | |
| Barium | 110 | | |
| Bervllium | < 0.3 | | |
| Bismuth | 10 | | |
| Boron | < 5 | | |
| Cadmium | < 3 | 10 | 6 |
| Calcium | 5600 | | 4900 |
| Cerium | < 24 | | |
| Chromium | 21 | | 34 |
| Cobalt | < 6 | | |
| Copper | 450 | | 572 |
| Gallium | < 11 | | 16 |
| Germanium | < 13 | | 2 |
| Gold | < 3 | | |
| Iron | 1,880 | | 4,200 |
| Lanthanum | < 0.8 | | |
| Lead | 49 | 354 | 613 |
| Lithium | < 0.4 | | |
| Magnesium | 730 | | |
| Manganese | 130 | | 194 |
| Mercury | 2.0 | 0.4 | |
| Molybdenum | < 13 | 23 | |
| Nickel | <15 | | 14 |
| Platinum | <12 | | |
| Potassium | 4300 | | 3200 |
| Selenium | < 0.4 | 0.5 | 8 |
| Silicon | 22,000 | | 29,200 |
| Silver | < 4 | | |
| Sodium | 2000 | | |
| Strontium | 39 | | |
| Thallium | < 4 | | |
| Tin | < 20 | 4 | 27 |
| Vanadium | 2.8 | | 154 |
| Zinc | 310 | 871 | 763 |
| Zirconium | < 2 | | |

* Processable composite.

**Source:** Cal. Recovery Systems, Inc., North Santa Clara County Comprehensive Waste Characterization Study (1982-83) T. VI-11, at 52 (1984).

TABLE 3: Average Pesticide and Herbicide Analysis of Organic Fraction of MSW as a Function of Waste Type

| | Concentration (ppb)* | | | |
|---|---|---|---|---|
| Compound | Rear Loader | Front Loader | Debris Box | Processable Composite |
| **Chlorinated Pesticides** | | | | |
| Aldrin | 28 | 40 | 62 | 43 |
| BHC | 214 | 87 | 104 | 134 |
| Chlordane | < 12 | < 59 | < 30 | < 35 |
| DDE | < 11 | < 110 | < 13 | < 45 |
| DDT | < 11 | < 207 | < 38 | < 92 |
| Dieldrin | < 5 | < 220 | < 8 | < 85 |
| Endrin | < 5 | < 17 | < 10 | < 11 |
| Heptachlor | 23 | 22 | < 22 | < 23 |
| Heptachlor Epoxide | < 4 | < 22 | < 16 | < 14 |
| Kepone | < 6 | < 26 | < 12 | < 15 |
| Methoxychlor | < 7 | < 32 | < 19 | <20 |
| Mirex | < 6 | <29 | < 15 | < 17 |
| PCB | < 19 | < 80 | < 44 | < 49 |
| Toxaphene | < 75 | <320 | < 190 | < 200 |
| **Phospate Pesticides** | | | | |
| Diazinon | 180 | 350 | 330 | 290 |
| Ethyl Parathion | 300 | < 1100 | < 180 | < 560 |
| Melathion | < 207 | < 1700 | < 460 | < 830 |
| Methyl Parathion | < 4500 | <1813 | <2600 | < 2930 |
| **Chlorinated Phenoxyacid Herbicides** | | | | |
| 2,4-D | 510 | 400 | 510 | 470 |
| 2,4,5-T | < 23 | < 23 | < 23 | < 23 |
| 2,4,5-TP (Silvex) | < 12 | < 12 | < 12 | < 12 |

* "Results presented on an oven-dry basis. The < sign, where used, indicates the detection limit for individual samples and that no substance was found above the given detection limit." CAL. RECOVERY SYSTEMS, INC., NORTH SANTA CLARA COUNTY COMPREHENSIVE WASTE CHARACTERIZATION STUDY (1982-83) T. VI-7, at 46 (1984).

| TABLE 4: Renewable Energy Funding Levels and Program Duration | | | | |
|---|---|---|---|---|
| State | Approximate Annual Funding ($ millions) | Per-Capita Annual Funding ($) | Per-MWh Funding ($) | Funding Duration |
| CA | 135 | 4.0 | 0.58 | 1998 – 2011 |
| CT | 15 – 30 | 4.4 | 0.50 | 2000 – indefinite |
| DE | 1 (maximum) | 1.3 | 0.09 | 10/1999 – indefinite |
| IL | 5 | 0.4 | 0.04 | 1998–2007 |
| MA | 30 – 20 | 4.7 | 0.59 | 1998 – indefinite |
| MT | 2 | 2.2 | 0.20 | 1999 – 2005 |
| NJ | 30 | 3.6 | 0.43 | 2001–2008 |
| NM | 4 | 2.2 | 0.22 | 2007 – indefinite |
| NY | 6 – 14 | 0.7 | 0.11 | 7/1998 – 6/2006 |
| OH | 15 – 5 (portion of) | 1.3 | 0.09 | 2001 – 2010 |
| OR | 8.6 | 2.5 | 0.17 | 3/2002 – 2/2011 |
| PA | 10.8 (portion of) | 0.9 | 0.08 | 1999 – indefinite |
| RI | 2 | 1.9 | 0.28 | 1997 – 2002 |
| WI | 1 – $4.8 | 0.9 | 0.07 | 4/1999 – indefinite |

**Source:** Mark Bolinger et al., *States Emerge as Clean Energy Investors: A Review of State Support for Renewable Energy*, 14 ELECTRICITY J. 82, 83 (2001), *available at* http://cleanenergystates.org/CaseStudies/bolWiserSbcEj_2001.pdf

| TABLE 5: Portfolio Standards and Trust Funds in States | | |
|---|---|---|
| State Name | Renewable Energy Trust Fund[1] | Portfolio Standards[2] |
| Arizona | | 15% by 2025 |
| California | 2002–2006: $135 million/yr.<br>2007–2011: $150 million/yr. | 20% by 2010 |
| Colorado | $860,265 in the first year<br>$1.3 million/year thereafter | 20% by 2020 (IOUs)<br>10% by 2020 (co-ops) |
| Connecticut | $20 million annually | 10% by 2010 |
| Delaware | $1.5 million annually | 10% by 2019 |
| D.C. | 2005: $9.5 mil. collected;<br>2006: $10.5 mil. collected | 11% by 2022 |
| Hawaii | | 20% by 2020 |
| Illinois | 1998–2007: ~ $10 million | 8% by 2013[3] |
| Iowa | | 105 MW |
| Maine | Dependent on voluntary contributions by electric customers | 30% by 2000 |
| Maryland | | 7.5% by 2019 |
| Massachusetts | 1998–2002: $150 million;<br>$25 million/yr. thereafter | 4% by 2009 + 1% annual increase |
| Minnesota | $16 million annually | 25% by 2025 |
| Montana | $14.9 million annually | 15% by 2015 |
| Nevada | | 20% by 2015 |
| New Jersey | 2001–2008: $1.23 billion | 22.5% by 2021 |
| New Mexico | | 20% by 2020 (IOUs)<br>10% by 2020 (co-ops) |
| New York | $1.86 billion through 2011 | 24% by 2013 |
| Ohio | $100 million over 10 years | |
| Oregon | $12 million over 10 years | |
| Pennsylvania | Varies by fund | 18% by 2020 |
| Rhode Island | ~$2.4 million over 10 years | 15% by 2020 |
| Texas | | 5880 MW by 2015 |
| Vermont | Receives $6–$7.2 million/year | RE meets load growth by 2012[4] |
| Wisconsin | Annual amount varies | 10% by 2015 (varies by utility) |

[1] These figures represent the total fund for renewables. Information about various state Renewable Energy Trust Funds can be found at: http://www.dsireusa.org/library/includes/type. cfm?EE=0&RE=1.
[2] INTERSTATE RENEWABLE ENERGY COUNCIL, RENEWABLES PORTFOLIO STANDARD (2007), *available at* http://www.dsireusa.org/document/SummaryMaps/RPS_Map.ppt.
[3] State Goal.
[4] *Id.*

TABLE 6: "Renewable" Resources as Defined in State Statutes

| State | Solar | Wind | Fuel Cell | Methane/ Landfill | Biomass | Trash-to-Energy | Hydro | Tidal | Geothermal | Photo Voltaic | Dedicated Crop |
|---|---|---|---|---|---|---|---|---|---|---|---|
| California | x | x | | x | x | x | x | x | x | x | x |
| Connecticut | x | x | x | x | x | x | x | | | x | x |
| Illinois | x | x | | | x | x | x | | | x | x |
| Maine | x | x | x | | x | x | x | x | x | x | x |
| Massachusetts | x | x | x | x | x | x | x | x | | x | x |
| Nevada | x | x | x | | | | | | x | x | x |
| New Jersey | x | x | x | x | x | x | x | x | x | x | x |
| New Mexico | x | x | x | x | x | x | x | x | x | x | x |
| New York | x | x | | x | | x | x | x | x | x | x |
| Oregon | x | x | | x | | x | x | x | x | x | x |
| Pennsylvania | x | x | | x | x | x | x | | x | x | x |
| Rhode Island | x | x | | x | x | x | x | | | x | x |
| Texas | x | x | | x | x | x | x | x | x | x | x |
| Wisconsin | x | x | x | | x | x | x | x | x | | |

Note: "Photovoltaic" is likely included within "solar" in some states; "methane" and or "trash–to-energy" may be included within a broad definition of "biomass."

**Sources:** CAL. PUB. RES. CODE § 25741 (West 2006); CONN. GEN. STAT. ANN. § 16-1 (West 2006); MASS. GEN. LAWS ch. 25A, § 11F(b) (2006); ME. REV. STAT. ANN. tit. 35-A, § 3210 (2005); NEV. REV. STAT. § 704.7811 (2005); N.J. ADMIN. CODE § 14:8-2.2; 14:8-2.5; 14:8-2.6 (2006); N.M. STAT. § 62-16-3(D) (2006); OR. REV. STAT. § 469.185 (2006); 73 PA. CONS. STAT. § 1648.2 (2005); R.I. GEN. LAWS § 39-26-5 (2005); TEXAS UTIL. CODE ANN. § 25.173(c)(15) (2004); WIS. STAT. § 196.378(1)(h) (2005). Illinois Commerce Commission, Resolution, Response to Governor's Sustainable Energy Plan for the State of Illinois 2 (2005), *available at* http://www.dsireusa.org/documents/Incentives/IL04R.pdf; NY PSC Order, Case 03-E-0188, Sept. 24, 2004, *available at* http://www.dsireusa.org/documents/Incentives/NY03R.pdf

| TABLE 7: Net Metering By State[1] | | | | |
|---|---|---|---|---|
| State | Eligible Technology | Eligible Customers Limits | Size Limits | Price |
| Arizona | Varies by Utility | All customer classes | ≤ 10kW | NEG purchased monthly by utility @ average monthly market price minus a price adjustment |
| Arkansas | Renewables, fuel cells and microturbines | All customer classes | ≤ 25kW residential ≤ 300kW commercial | Monthly NEG credited to customer's @ retail rate; annual NEG granted to utility |
| California | Renewables | All customer classes | ≤ 1000kW | Monthly NEG credited to customer; annual NEG granted to utilities |
| Colorado | Renewables and fuel cells | Varies by utility | ≤ 2000 kW | NEG carried forward month-to-month |
| Connecticut | Renewables, MSW cogeneration, and fuel cells | Commercial and residential customers | ≤ 50kW cogeneration ≤ 100kW renewables | NEG purchased by utility at spot-market energy rate |
| Delaware | Renewables | Commercial, residential | ≤ 25 kW | Varies |
| Florida | Photovoltaics, wind | All classes | <10kW | Monthly NEG granted to customer |
| Georgia | Photovoltaics, wind, fuel cells | All classes | ≤ 10 kW residential ≤ 100 kW commercial | Monthly NEG or total generation purchased at avoided cost or higher rate if green priced |
| Hawaii | Solar, wind, biomass, hydro | Residential, commercial, and government | ≤ 50 kW | Monthly NEG carried forward; annual NEG granted to utilities |
| Idaho | Varies by utility | Agricultural, residential and commercial | ≤ 25 kW residential; ≤ 100 kW commercial (Avista ≤ 25 kW) | NEG varies by utility |
| Illinois | Photovoltaics and wind | All customer classes; (Commonwealth Edison only) | ≤ 40 kW | NEG purchased at avoided cost monthly plus annual payment to bring payment to retail rate |
| Indiana | Photovoltaics, Wind, and small Hydro electric | Residential and Schools | ≤ 10kW | Monthly NEG credited forward |

| TABLE 7: Net Metering By State[1] | | | | |
|---|---|---|---|---|
| Iowa | Renewables and MSW | All customer classes | ≤ 500 kW | NEG credited to customer's next bill |
| Kentucky | Photovoltaics | All customer classes | ≤ 15 kW | Monthly NEG granted to customer |
| Louisiana | Renewables, cogeneration and fuel cells | Residential, commercial, agricultural | ≤ 25 kW residential; ≤ 100 kW commercial and farm | Monthly NEG credited to customer @ utility's retail rate |
| Maine | Renewables and fuel cells | All customer classes | ≤ 100 kW | Credited forward monthly; annual NEG granted to utilities |
| Maryland | Renewables | Commercial, residential, government and schools | ≤ 500kW | Monthly NEG granted to customers |
| Massachusetts | MSW, renewables and cogeneration (qualifying facilities) | All customer classes | ≤ 60 kW | Monthly NEG credited forward @ average monthly market rate |
| Michigan | Renewables, MSW | All classes | < 30kW | NEG credited forward; annual NEG forfeited |
| Minnesota | Renewables, MSW, and cogeneration (qualifying facilities) | All customer classes | ≤ 40 kW | NEG purchased at utility average retail energy rate |
| Montana | Solar, wind, and hydro | All customer classes | ≤ 50 kW | Monthly NEG credited forward; annual NEG granted to utilities at the end of each calendar year |
| Nevada | Renewables | All customer classes | ≤30 kW | NEG carried forward indefinitely |
| New Hampshire | Solar, wind and hydro | All customer classes | ≤ 25kW | NEG credited to next month |
| New Jersey | Renewables and fuel cells | Residential and commercial | ≤2MW | Monthly NEG credit to customer; annualized NEG purchased at avoided cost |

| | | | | |
|---|---|---|---|---|
| New Mexico | Renewables, MSW and cogeneration | All customer classes | ≤ 80 MW | NEG credited to next month, or monthly NEG purchased at avoided cost (utility choice) |
| New York | Biogas, wind, and Photovoltaics | Agricultural and residential only | ≤ 10 kW solar residential; ≤ 25 kW wind residential; ≤ 400 kW farm biogas systems ≤ 125 kW farm wind | Monthly credited forward; annualized NEG purchased at avoided cost |
| North Carolina | Renewables | All classes | ≤ 20 kW residential; ≤ 100 kW non-residential | NEG credited forward to customer; annual granted to utility |
| North Dakota | Renewables, MSW and cogeneration | All customer classes | ≤ 100 kW | Monthly NEG purchased at avoided cost |
| Ohio | Renewables, microturbines and fuel cells | All customer classes | No limit per system | NEG purchased at unbundled generation rate |
| Oklahoma | Renewables, MSW and cogeneration | All customer classes | ≤ 100 kW or ≤ 25,000 kWh/year | Monthly NEG granted to utility or credited to customer's next bill (varies by utility) |
| Oregon | Solar, wind, fuel cells and hydro | All customer classes | ≤ 25 kW | NEG purchased at avoided cost or credited to following month |
| Pennsylvania | Renewables and fuel cells | All customer classes | ≤50kW residential; ≤ 1MW non-residential | Customer compensated monthly at utility's avoided cost |
| Rhode Island | Renewables, MSW and fuel cells | All customer classes | ≤ 25kW (up to 1MW in Narragansett service territory) | Monthly NEG credited forward; annual NEG granted to utilities |
| Texas | Renewables only | All customer classes | ≤ 50 kW | Monthly NEG purchased at avoided cost |
| Utah | Solar, Photovoltaics, wind, hydro and fuel cells | All customer classes | ≤ 25kW | NEG credited within billing cycle at avoided cost, any unused credit granted to utility at end of calendar year |

| | | | | |
|---|---|---|---|---|
| Vermont | Photovoltaics, wind, fuel cells, anaerobic digesters | All customer classes | ≤15 kW residential; ≤ 150 kW farm biogas | Monthly NEG carried forward, annual NEG granted to utilities |
| Virginia | Renewables and MSW | All customer classes | ≤10 kW residential; ≤ 500 kW non-residential | Monthly NEG carried forward; annual NEG granted to utilities (power purchase agreement is allowed) |
| Washington | Solar, wind, fuel cells and hydro | All customer classes | ≤ 100 kW | Monthly NEG carried forward; annual NEG granted to utility |
| Wisconsin | Renewables, MSW and cogeneration | All customer classes | ≤ 20 kW | Monthly NEG purchased at retail rate for renewables, avoided cost for non-renewables |
| Wyoming | Solar, wind, hydro and biomass | All customer classes | ≤ 25 kW | Monthly NEG carried forward; annual NEG purchased at avoided cost |
| Puerto Rico | Renewables | Residential | ≤ 50kW | Excess carried over month-to-month; excess purchased at avoided cost month-to-month |

[1] DSIRE.org, Net Metering Rules for Renewable Energy, http://www.dsireusa.org/library/includes/seeallincentivetype.cfm?type=Net&currentpageid=7&back=regtab&EE=0&RE=1type.cfm?EE=0&RE=1 (2007).

Table Abbreviation Key:

**KW** is a kilowatt, a measure of electric generation capacity.
**MSW** is municipal solid waste-to-electricity conversion, usually accomplished by combusting the waste in a boiler to drive a generator.
**NEG** is net electric generation, the surplus of electricity sold to the utility over the amount of electricity purchased from the utility over a given period (month or year).