Solar Energy Development on Contaminated Land in Minnesota: Opportunities & Challenges

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The U.S. Environmental Protection Agency (EPA) created the program "RE-Powering America's Land" to encourage the development of renewable energy on land that is currently or was formerly contaminated.[1] This paper discusses the arguments for locating renewable energy on contaminated lands, focusing on solar energy. It lists sites in Minnesota where contaminated land is already supporting solar power generation. The paper also describes barriers to solar development on contaminated land, and reviews some of the technical methods that can help developers overcome those barriers.

The research for this paper included conversations with solar developers, attorneys practicing in energy and real estate law, state and federal regulatory staff, engineers and environmental scientists, and representatives of investor-owned utilities.[2] While the conversations yielded extremely helpful information, it is important to note that there are other stakeholders whose opinions and expertise are not represented here.

In this paper, the phrase "contaminated land" refers to sites where one or more hazardous substances, pollutants, or contaminants are present or potentially present, adding technical and regulatory dimensions to land reuse that would not exist but for the presence of contamination. Such sites include properties where a planned or ongoing removal action under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) is taking

[1] *RE-Powering America's Land: Siting Renewable Energy on Potentially Contaminated Lands, Landfills, and Mine Sites*, U.S. ENVTL. PROT. AGENCY, http://www.epa.gov/oswercpa/ (last visited May 14, 2015).
[2] Several people who gave generously of their time are not cited, but their insights informed this paper.

place; sites listed on the National Priorities List or proposed for listing;[3] closed landfills; sites subject to corrective action under the Resource Conservation and Recovery Act;[4] and brownfields.[5] The paper focuses on Minnesota, but draws on relevant examples from other states.

Part I: Why Develop Renewable Energy on Contaminated Land?

There are numerous reasons why using renewable energy technologies to generate power on contaminated land is a good idea. First, it is one way to respond to the exigencies of climate change. This paper starts from the premise that in order to mitigate the worst consequences of climate change, we must drastically reduce consumption of fossil fuels in all sectors of the U.S. economy, including power production.[6] To achieve that end, we should look for all opportunities to develop zero- and low-carbon energy resources.

At utility scale, solar and wind energy facilities require large land areas.[7] Contaminated land represents a remarkable amount of acreage in the Unites States.[8] In Minnesota, 121 square miles of brownfields were enrolled in state cleanup programs by 2014, but thousands of contaminated or potentially contaminated sites remain unaddressed.[9] The EPA has identified almost 15 million acres of potentially contaminated sites with the technical potential for solar, wind, biomass, and geothermal resources to produce one million megawatts (MW) of energy.[10]

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[3] *See* 42 U.S.C. § 9605(a)(8)(B) (2014).
[4] As defined under 42 U.S.C. §§ 6924(u), 6928(h) (2014).
[5] As defined by 42 U.S.C. § 9601(39) (2014).
[6] *See, e.g.*, R.K. PACHAURI & L.A. MEYER, EDS., INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, 2014, CLIMATE CHANGE 2014: SYNTHESIS REPORT. CONTRIBUTION OF WORKING GROUPS I, II AND III TO THE FIFTH ASSESSMENT REPORT OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE (2015).
[7] Charles B. Howland, *Brightfields: Sustainable Opportunities for Renewable Energy Projects on Environmentally Impaired Lands*, 29 NAT. RESOURCES & ENV'T 41, 42 (2014).
[8] U.S. DEP'T OF HOUS. & URBAN DEV., BROWNFIELDS FAQS (2012), *available at* https://www.hudexchange.info/resource/3180/brownfields-frequently-asked-questions/.
[9] MINN. BROWNFIELDS, BENEFITS OF BROWNFIELD REDEVELOPMENT IN MINNESOTA 2 (2014), *available at* http://mnbrownfields.org/land-recycling-101/benefits-of-cleanup-redevelopment/.
[10] U.S. ENVTL. PROT. AGENCY, HANDBOOK ON SITING RENEWABLE ENERGY PROJECTS WHILE ADDRESSING ENVIRONMENTAL ISSUES 1, *available at* http://www.epa.gov/oswercpa/ (last visited May 8, 2015) [hereinafter HANDBOOK ON SITING RENEWABLE ENERGY PROJECTS].

EPA has identified and mapped well over a hundred sites throughout Minnesota that have potential for solar, wind, and biomass facilities.[11] Where contaminated property is not suitable for residential, commercial, or other industrial reuse, renewable energy installations such as solar arrays or wind turbines could make the acreage economically productive while decreasing greenhouse gas emissions. It may be feasible to use renewable energy generated on site to power investigation, remediation, and monitoring activities.[12] And where contaminated properties are suitable for residential or commercial reuse, renewable energy could be integrated in redevelopment plans to serve the electricity needs of onsite users or the larger power grid.

Developing renewable energy resources on contaminated land could also help state and local governments meet their climate and energy goals. Minnesota has established statewide greenhouse gas emissions reduction goals by statute.[13] There are also several statutory provisions that require certain electric utilities to increase the amount of power they generate or otherwise procure from renewable energy sources, calculated as a percentage of their total retail electric sales to retail customers in Minnesota.[14] While utilities are ahead of schedule in meeting their requirements under the state's renewable portfolio standard, the state as a whole is projected to fall short of meeting the greenhouse gas emissions reduction goals set for 2015 and 2025.[15]

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[11] *See Mapping and Screening Tools: Re-Powering Mapper*, U.S. ENVTL. PROT. AGENCY, http://www.epa.gov/oswercpa/rd_mapping_tool.htm#i_map (click on EPA Region 5 to view Minnesota sites in Google Earth, or view all sites on a national map by downloading separate layers such as "utility scale" or "solar on landfills"). EPA's mapping tool only includes sites where an EPA grant has been awarded, or where EPA brownfields funding supported an assessment or cleanup activity. HANDBOOK ON SITING RENEWABLE ENERGY PROJECTS, *supra* note 10, at 20. There must be numerous additional suitable sites in Minnesota, given that many land surfaces in the state are rated as having "good" to "optimal" solar resources. *See Minnesota Solar Suitability Analysis*, UNIV. OF MINN., http://solar.maps.umn.edu/index.php (last visited May 26, 2015).

[12] *See* U.S. ENVTL. PROT. AGENCY, EPA 542-F-11-006, GREEN REMEDIATION BEST MANAGEMENT PRACTICES: INTEGRATING RENEWABLE ENERGY INTO SITE CLEANUP (2011).

[13] MINN. STAT. § 216H.02.1 (2014).

[14] MINN. STAT. §§ 216B.1691.2b, 2f (2014).

[15] Elizabeth Dunbar & Dan Kraker, *Minnesota's Efforts to Fight Climate Change Lose Steam*, MPR NEWS, Feb. 6, 2015, http://www.mprnews.org/story/2015/02/06/climate-change-enough.

Further, total U.S. electricity demand is projected to increase by 29% between 2012 and 2040.[16] All of these factors suggest that Minnesota will need more power generated from renewable energy. Contaminated land could play an important role in meeting the state's need.

Contaminated lands tend to be concentrated in urban and industrial areas in Minnesota,[17] so solar development on these properties presents an even greater opportunity for local governments to achieve their own climate and energy goals. The City of Minneapolis has adopted greenhouse gas reduction goals and renewable energy targets.[18] The city's *Climate Action Plan* sets a goal of increasing the use of "local or directly purchased renewable energy to 10 percent of the total electricity consumed in the city by 2025."[19] Generating power on contaminated land in Minneapolis and in the larger metropolitan region would help fulfill this goal. Among its other aims is promoting the construction of solar-ready buildings and net-zero energy buildings.[20] When contaminated properties are remediated and redeveloped for residential and commercial use, redevelopment plans could support city goals by integrating these types of structures.

Because contaminated sites are compromised to some degree, by siting solar projects on them, developers, landowners, and local and state governments may be able to avoid the land use conflicts that sometimes occur when renewable energy development is proposed on more pristine

[16] *Growth in Electricity Use Slows, But Use Still Increases by 29% from 2012 to 2040*, ENERGY INFO. ADMIN., Apr. 14, 2015, http://www.eia.gov/forecasts/AEO/MT_electric.cfm.
[17] *See* MINN. BROWNFIELDS, *supra* note 9.
[18] CITY OF MINNEAPOLIS, MINNEAPOLIS CLIMATE ACTION PLAN 15 (2013), *available at* http://www.ci.minneapolis.mn.us/sustainability/climate/index.htm; Press Release, City of Minneapolis, City Sets Goal to Reduce Greenhouse Gas 80 Percent by 2050 (Apr. 25, 2014), *available at* http://www.ci.minneapolis.mn.us/news/WCMS1P-123878.
[19] CITY OF MINNEAPOLIS, *supra* note 18.
[20] *Id.* at 21-22.

sites.[21] Depending on their location, large solar arrays and wind farms may pose threats to endangered species, cultural resources, scenic views, and solitude.[22] Contaminated land in Minnesota is not extensive enough to fulfill state demand for renewable energy, but siting such generation on these properties could relieve pressure on greenfields, scenic areas, and wild habitats.

Proximity to existing infrastructure—including transmission and distribution lines, electrical substations, roads, and railroads—is often cited as a reason to locate renewable energy generation on contaminated land.[23] Easily accessible transportation for construction materials and later, for the energy produced on site, will often reduce a project's need for capital.[24] Most of Minnesota's contaminated land is located in urban and industrial areas,[25] which also happens to be where infrastructure is concentrated.[26] On some properties, infrastructure sits entirely unused (and aging). For instance, Ross Lovely of the Duluth Economic Development Agency characterized grid connectivity at the U.S. Steel Plant Duluth Works Site as a "four-lane highway ramp" with no traffic.[27] If we can produce more power locally using solar on sites served by existing infrastructure, it may also lessen the need to build as many new long-distance

[21] *See, e.g.*, Shannon Mullen, *Lawsuit Seeks to Derail Six Flags Solar Plan*, ASBURY PARK PRESS, May 5, 2015, http://www.app.com/story/news/local/2015/05/04/environmental-groups-file-lawsuit-stop-six-flags-solar-farm/26892107/ (environmental groups filed suit to stop development of a 90-acre, 21.9-MW solar farm that would require clearing approximately 19,000 trees).
[22] Sara C. Bronin, *Curbing Energy Sprawl with Microgrids*, 43 CONN. L. REV. 547, 549, 553-56 (2011); John Copeland Nagle, *Green Harms Of Green Projects*, 27 NOTRE DAME J.L. ETHICS & PUB. POL'Y 59, 62-71, 71-73 (2013); *see also* Mark Steil, *Planned Solar Farm in Southwest MN Draws Fire from Residents*, MPR NEWS, Jan. 21, 2015, http://www.mprnews.org/story/2015/01/21/marshall-solar-installation.
[23] *See, e.g.*, NAT'L ASS'N OF LOCAL GOV'T ENVTL. PROF'LS, CULTIVATING GREEN ENERGY ON BROWNFIELDS: A NUTS AND BOLTS PRIMER FOR LOCAL GOVERNMENTS 15 (2012).
[24] *Id.*
[25] *See supra* text accompanying note 17.
[26] *See, e.g.* OFFICE OF GEOGRAPHIC & DEMOGRAPHIC ANALYSIS, ADMIN MINNESOTA, MINNESOTA: ELECTRIC TRANSMISSION LINES AND SUBSTATIONS (2007), *available at* http://www.mngeo.state.mn.us/chouse/utilities.html#transmission (showing the locations of lines 60 kV or larger and substations).
[27] Telephone interview with Ross Lovely, Bus. Developer, City of Duluth (Apr. 15, 2015).

transmission lines, which require a lengthy permitting and siting process, and are frequently subject to local opposition.[28]

Siting renewable energy on contaminated land could also contribute to recent growth in clean energy sector jobs.[29] Employment in Minnesota's solar energy sector has increased 16 percent in the last five years,[30] and on average, clean energy jobs pay workers better than other Minnesota jobs.[31] Developing solar energy on contaminated land, which is clustered in urban and industrial areas, can mean more jobs in communities experiencing low- or under-employment. Where people who live in areas affected by contaminated land do not possess the necessary skills to access these employment opportunities, communities may be able to leverage grants or other incentives to enable them to train individuals in environmental assessment and cleanup, and in solar photovoltaic (PV) installation.[32] Solar development can also create opportunities to hire military veterans who have acquired skills in programs such as "Solar Ready Vets."[33]

Part II: Existing Solar Projects on Contaminated Land in Minnesota

Solar PV installations are already producing electricity on contaminated land in Minnesota. It is not clear how many of these sites exist, however. State and local agencies track contaminated and potentially contaminated sites, as well as redevelopment of these sites, but no

[28] *Cf.* Alexandra B. Klass, *The Electric Grid at a Crossroads: A Regional Approach to Siting Transmission Lines*, U.C. DAVIS L. REV. (forthcoming) (discussing the complexities of siting long-distance interstate transmission lines).
[29] Over the past 15 years, the number of jobs in Minnesota's clean energy economy increased seven times faster than overall job growth. COLLABORATIVE ECONS, INC., MINNESOTA CLEAN ENERGY ECONOMY PROFILE 20 (2014), *available at* http://mn.gov/deed/data/research/clean-energy.jsp.
[30] *Id.* at 23.
[31] *Id.* at 30.
[32] *See, e.g.*, *Environmental Workforce Development and Job Training*, OFFICE OF BROWNFIELDS & LAND REVITALIZATION, U.S. ENVTL. PROT. AGENCY, http://www.epa.gov/brownfields/job.htm (last visited May 6, 2015); JESSE DEAN, ET AL., U.S. DEP'T OF ENERGY, INTEGRATING PHOTOVOLTAIC SYSTEMS INTO LOW-INCOME HOUSING DEVELOPMENTS: A CASE STUDY ON THE CREATION OF A NEW RESIDENTIAL FINANCING MODEL AND LOW-INCOME RESIDENT JOB TRAINING PROGRAM 5-6 (2011).
[33] Timothy Cama, *Obama Launches Solar Training Program for Veterans*, HILL, Apr. 3, 2015, http://thehill.com/policy/energy-environment/237853-obama-launches-solar-training-program-for-vets.

agency or organization tracks which brownfield redevelopments integrate solar or other renewable energy technologies.[34] EPA maintains a list of completed renewable energy projects on contaminated land, though it is not intended to serve as a comprehensive list.[35]

Existing solar installations in Minnesota can be categorized as follows. There are brownfields that were redeveloped in the past, but which are now adding solar PV to an existing structure. There is at least one "green remediation" site, where a solar installation provides electricity for ongoing monitoring and remediation activities.[36] There are brownfield redevelopment projects that integrate onsite solar generation with other site uses beginning at the planning stage. And there are solar installations appearing on closed landfills. Because there is no comprehensive list of contaminated land where renewable energy is being used, it is not possible to say that these categories describe all such projects. The following list includes sites the author found based on Internet research and conversations with people who are familiar with solar or brownfield redevelopment. Some of the following sites were found by searching for prominent solar projects and then using the Minnesota Pollution Control Agency's "What's in My Neighborhood" application to find out about potential contamination and remediation efforts on these properties.[37]

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[34] Email from Kevin Carroll, Bus. Dev. Principal Project Coordinator, City of Minneapolis–Cmty Planning & Econ. Dev., to Danielle Meinhardt (Mar. 31, 2015) (on file with author); Email from Kristin Lukes, Dir. of Brownfields & Redev., Minn. Dep't of Emp't & Econ. Dev., to Danielle Meinhardt (Apr. 1, 2015) (on file with author); Interview with Gil Gabanski, Land and Water, Contaminated Lands Unit, Environment and Energy Department, Hennepin County Public Works, in Minneapolis, MN (Apr. 21, 2015); Telephone interview with Stacy Miller, Solar Policy Specialist, Minn. Dep't of Commerce (Apr. 16, 2015).

[35] U.S. ENVTL. PROT. AGENCY, RE-POWERING AMERICA'S LAND INITIATIVE: PROJECT TRACKING MATRIX (2014).

[36] Depending on the stage of cleanup, a responsible party, or a party who is paying for cleanup to achieve a standard necessary for redevelopment, can save money by powering remediation equipment with renewable energy. Telephone interview with Pete Pedersen, Managing Principal, Brightfields Development L.L.C. (May 5, 2015).

[37] *See What's in My Neighborhood*, MINN. POLLUTION CONTROL AGENCY, http://cf.pca.state.mn.us/wimn/search.cfm.

A. Solar installations added after redevelopment

- **Minneapolis-St. Paul International Airport (MSP)**. 3-MW array currently under construction on top of two parking ramps; project received support from Xcel Energy's Renewable Development Fund.[38] MSP site in use as airport since 1920,[39] multiple tank sites and investigation and cleanup sites on the property.[40]

- **Science Museum of Minnesota & RiverCentre Parking Ramp**. 10.4-kilowatt (kW) solar PV installation on museum's flat roof since June 2012.[41] Several actions under the Minnesota Pollution Control Agency (MPCA) Voluntary Investigation and Cleanup Program, and institutional controls in place.[42] Adjacent RiverCentre parking ramp's south-facing wall hosts 82-kW PV system.[43] Shell gasoline station previously located on portion of parking ramp site, tank removal has occurred.[44]

B. Green remediation

- **FMC (Fridley Plant) Superfund site**. FMC Corporation (now BAE) remediated most solvent contamination on 18-acre site in 1987,[45] gas extraction system and groundwater well pumping system remain in operation.[46] 14.7-kW solar PV system installed in 2009, generates 30% of electricity needed to operate onsite remediation.[47]

C. Sites integrating solar at the redevelopment stage

- **Old Home Plaza**. Project to redevelop former dairy processing plant and automotive maintenance garage site into mixed-use development that includes affordable housing,

[38] Patrick Kennedy, *MSP Airport Plans to Build State's Largest Solar Power Project*, Oct. 5, 2014, http://www.startribune.com/msp-airport-plans-to-build-state-s-largest-solar-power-project/277973561/.
[39] *History*, MINNEAPOLIS-ST. PAUL INT'L AIRPORT, https://www.mspairport.com/about-msp/history.aspx (last visited May 12, 2015).
[40] *What's in My Neighborhood*, MINN. POLLUTION CONTROL AGENCY, http://cf.pca.state.mn.us/wimn/search.cfm (last visited May 12, 2015) (search for MSP by location).
[41] *Solar Projects and Initiatives*, SAINT PAUL, MINNESOTA, http://www.stpaul.gov/solar (last visited May 12, 2015).
[42] *Science Museum*, MINN. POLLUTION CONTROL AGENCY, http://cf.pca.state.mn.us/wimn/siteInfo.cfm?siteid=171993 (last visited May 12, 2015).
[43] *St. Paul Parking Ramp Serves as a Model for Sustainability*, OFFICE OF ENERGY EFFICIENCY & RENEWABLE ENERGY, U.S. DEP'T OF ENERGY, Apr. 17, 2014, http://energy.gov/eere/articles/st-paul-parking-ramp-serves-model-sustainability.
[44] *Former Shell Station*, MINN. POLLUTION CONTROL AGENCY, http://cf.pca.state.mn.us/wimn/siteInfo.cfm?siteid=232324 (last visited May 12, 2015).
[45] *Sites in Reuse in Minnesota*, U.S. ENVTL. PROT. AGENCY, http://www.epa.gov/superfund/programs/recycle/live/region5_mn.html (last visited May 12, 2015).
[46] BAE SYSTEMS, SOUTH SITE REMEDIATION: SOLAR ENERGY (2009).
[47] *Id.*

retail space, and townhomes.[48] Received Metropolitan Council cleanup grant for soil vapor mitigation,[49] and Xcel Energy Renewable Development Fund grant[50] to support roof-mounted 252-kW solar PV project; all electricity to be consumed on site.[51]

- **Mississippi Watershed Management Organization (MWMO) Community Facility**. Long history of industrial and commercial use of site; contamination encountered during redevelopment.[52] Solar PV installation part of original redevelopment plan; MWMO received Made in Minnesota Solar Incentive Program grant from Minnesota Department of Commerce to complete solar project.[53]

- **Rice Creek Commons**. Mixed-use community integrating solar PV planned for portion of 427-acre Twin Cities Army Ammunition Plant (TCAAP) site; site has undergone extensive environmental remediation.[54] Ramsey County currently pursuing acquisition of site adjacent to TCAAP; 40 acres of site to be used for solar generation.[55] Soil contamination on that parcel requires remediation before development.[56]

- **Ford's Twin Cities Assembly Plant**. City of St. Paul studying energy efficiency and onsite renewable energy generation, with aim of creating mixed-use development on 125-acre site that will require minimal energy.[57] Contamination is or was present on different parts of site, now being remediated.[58]

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[48] Kevin Mahoney, *$2.5M in Cleanup Grants Pave Way for Grocer, Brewery*, TWIN CITIES BUS., June 27, 2013, http://tcbmag.com/News/Recent-News/2013/June/$2-5M-In-Cleanup-Grants-Paveway-For-Grocer,-Brewer.

[49] *Id.*; Peter Cox, *Affordable Housing Headed to St. Paul's Old Home Dairy*, MPR NEWS, Nov. 21, 2014, http://www.mprnews.org/story/2014/11/21/western-u-development.

[50] Press Release, Xcel Energy, Xcel Energy's Renewable Development Fund Awards $42 Million to Projects Benefiting Minnesota Customers (Mar. 11, 2014), *available at* http://www.reuters.com/article/2014/03/11/mn-xcel-energy-idUSnBw116710a+100+BSW20140311.

[51] XCEL ENERGY, XCEL ENERGY RENEWABLE DEVELOPMENT FUND PROJECT SELECTION REPORT CYCLE 4, Docket No. E002/M-12-1278 (2013).

[52] Mississippi Watershed Management Organization Community Facility, MINN. BROWNFIELDS, http://mnbrownfields.org/case-studies/mwmo/ (last visited May 12, 2015).

[53] Telephone interview with Max Dalton, Administrative Specialist, Miss. Watershed Mgmt. Org. (May 12, 2015) (site also makes use of geothermal heating and cooling).

[54] *See* EVER-GREEN ENERGY, ET AL., TCAAP ENERGY INTEGRATION RESILIENCY FRAMEWORK 3, 4, 6, 99 (2015).

[55] James Walsh, *Plan Could Make Arden Hills Development Energy Self-sufficient*, STAR TRIB., Apr. 7, 2015, http://www.startribune.com/printarticle/?id=298985241.

[56] EVER-GREEN ENERGY, ET AL., *supra* note 54, at 21.

[57] *Ford Site: A 21st-Century Community*, SAINT PAUL, MINNESOTA, http://www.stpaul.gov/21stCenturyCommunity (last visited May 13, 2015).

[58] *Ford Motor Co - Twin Cities Assembly*, MINN. POLLUTION CONTROL AGENCY, http://cf.pca.state.mn.us/wimn/siteInfo.cfm?siteid=396 (last visited May 13, 2015); Elizabeth Dunbar, Ford Dump Site Along Mississippi: Should it be Cleaned Up?, MPR NEWS, Aug. 25, 2014, http://www.mprnews.org/story/2014/08/25/ford-dump-site-mississippi-river.

- **Sites in Greater Minnesota**. City of Duluth building residential development on city-owned brownfield site, RFP required future site developer to consider incorporating solar.[59] Several former industrial sites in Duluth are prime candidates for installation of stand-alone solar PV systems.[60]

D. Closed landfills

- **City of Hutchinson**. Xcel Energy Renewable Development Fund grant will enable construction of solar PV system on city's closed landfill.[61]

- **MPCA closed landfills**. MPCA received funding for two of four landfill projects it entered in the 2014 Minnesota Department of Commerce Made in Minnesota solar incentive program lottery; two 40-kW arrays to be operational by end of June 2015.[62]

Part III: Barriers to Renewable Energy Development on Contaminated Land

As Part II illustrates, solar energy is already being developed on closed landfills, Superfund sites, and as part of commercial and residential redevelopments on brownfields in Minnesota. Yet it appears that barriers to further development remain. Almost everyone interviewed for this paper characterized potential liability as at least a complicating factor, while a few people explained that uncertainty as to liability was enough to make some solar developers disinterested in contaminated properties altogether.

While liability issues are part of any brownfield redevelopment, because siting renewable energy technologies on contaminated land is a relatively recent phenomenon, developers of these projects may face more unanswered questions. For instance, unforeseen slumping can occur on closed landfills, which could cause problems for solar arrays installed on top.[63] There is no case

[59] Email from Ross Lovely, Bus. Developer, City of Duluth, to Danielle Meinhardt (Apr. 16, 2015) (on file with author).
[60] Telephone interview with Ross Lovely, *supra* note 27 (discussing the possibility that portions of the Atlas site, the U.S. Steel site, and the St. Louis River Interlake/Duluth Tar Site could host solar arrays).
[61] Terry Davis, *Large Grant Could Move City Toward Solar Power*, HUTCHINSON LEADER.COM, Feb. 12, 2104, http://www.crowrivermedia.com/hutchinsonleader/news/large-grant-could-move-city-toward-solar-power/article_a73bbabb-225e-5e78-8173-f12b753ac08f.html.
[62] Telephone interview with Doug Day, Supervisor, Closed Landfill Program, Minn. Pollution Control Agency (Mar. 23, 2015).
[63] Telephone interview with Pete Pedersen, *supra* note 36.

law to suggest how a party would prove what portion of the slumping, if any, a solar array caused in such a situation.[64] Sometimes one stakeholder's desire for certainty is a stumbling block, as in the example of a town that wanted thirty years of proof that a solar array such as the one proposed for their landfill would work reliably.[65] At this time, such assurances are simply unavailable.

As more projects are completed and operational, however, liability responses are becoming better understood and investors are getting more comfortable with risk.[66] While no two projects are exactly the same, there are technical, regulatory, and financial tools that can help mitigate risks associated with developing solar energy on contaminated land. The remainder of this Part highlights some technical methods of addressing risk.

A. Solar PV can be a low-impact technology

Depending on the nature of contamination on a site, it may be necessary to avoid piercing a cap, or it may be necessary to avoid excavating or otherwise disturbing soils.[67] Fortunately, solar PV installation is not particularly invasive. Installing racking systems on the gigantic solar farms of the southwestern United States requires cement trucks and heavy equipment, but many racking systems require much lighter equipment—often no more than a pickup truck and a few workers.[68] Where relatively flat land is available and avoiding subsurface disturbance is important, a ballasted anchoring system would be ideal.[69] Ballast material—such as a pre-cast

[64] *Id.*
[65] *Id.*
[66] *Id.*
[67] *See* U.S. ENVTL. PROT. AGENCY & NAT'L RENEWABLE ENERGY LAB., BEST PRACTICES FOR SITING SOLAR PHOTOVOLTAICS ON MUNICIPAL SOLID WASTE LANDFILLS 39-40 (2013) [hereinafter BEST PRACTICES FOR SITING SOLAR PHOTOVOLTAICS]. As an example, the clay cap on the Atlas site in Duluth must remain intact in perpetuity. Telephone interview with Ross Lovely, *supra* note 27.
[68] Telephone interview with Pete Pedersen, *supra* note 36.
[69] The City of Hutchinson chose a ballasted system for its project to avoid penetrating the landfill cap. Telephone interview with John Paulson, Environmental Specialist, City of Hutchinson (May 4, 2015).

concrete block—is laid on top of the surface and the solar array support structure is attached to the ballast material.[70] No ground penetration is necessary. Operation and maintenance can be conducted by walking; no more access is needed than during initial construction.[71]

Where it is necessary or desirable to drive pilings into the ground, technology exists to minimize soil disturbance. For example, at a 40-acre, 6-MW solar farm located on a portion of the Aerojet General Corporation Superfund site in California, the developer used high-speed vibration to press the steel tracking system's vertical support beams into the ground.[72] This approach limited soil disturbance and, despite the use of specialized equipment, was cost-effective for this particular site.[73]

A successful 2-MW array on a Massachusetts landfill serves as a good example of other ways to safeguard a landfill's protective components.[74] During installation, developers used hand tools, "mini-excavator equipment," temporary access roads, and cast-in-place concrete, and they avoided marking the site in ways that might damage the landfill liner.[75]

B. Technical considerations specific to landfills

There is a lot of interest in constructing solar arrays on Minnesota's closed landfills, both from private and public developers.[76] Where MPCA is responsible for overseeing landfills under Minnesota's Landfill Cleanup Act, the agency must ensure that activities are protective of human

[70] BEST PRACTICES FOR SITING SOLAR PHOTOVOLTAICS, *supra* note 67, at 41.
[71] Interview with community solar developers, in Minneapolis, MN (Feb. 16, 2015).
[72] U.S. ENVTL. PROT. AGENCY, GREEN REMEDIATION AND UTILITY-SCALE SOLAR DEVELOPMENT: THE AEROJET GENERAL CORPORATION SUPERFUND SITE & SACRAMENTO COUNTY, CALIFORNIA 8-9 (2010).
[73] *Id.* at 6, 8.
[74] David Andrews & Robert Jackson, *Brownfields to Brightfields in Greenfield, Mass.*, BROWNFIELD RENEWAL.COM, Dec. 2010-Jan. 2011, at 8-9.
[75] *Id.* at 9.
[76] Telephone interview with Doug Day, *supra* note 62. Note that private parties may not derive profits or other benefits on land where general obligation bond money has been spent until after 37.5 years have passed. This creates a significant barrier to developing solar energy for private use or profit on landfills if public monies have been spent on cleanup. *Id.*

health and the environment, first and foremost.[77] Landfills are not suitable for active development; there can be no buildings on top of the landfill or within a certain distance of the waste.[78] But solar PV systems are a type of development that can be suitable for landfills, while providing income from a lease, or providing power that can be used on site for remediation activities.[79]

There are a number of liability issues that are specific to landfills, but there are technological means of addressing risk on these sites. The potential exists that landfill gas (i.e., methane mixed with various other gases and substances[80]) could migrate, and isolated incidents of sparking from the solar PV system could ignite the gas.[81] The City of Hutchinson's primary reason for selecting a low-voltage system was to reduce the risk that methane would migrate and cause an explosion.[82] In their best practices manual, the EPA and the U.S. Department of Energy's National Renewable Energy Laboratory suggest locating solar PV systems at a safe distance from landfill gas system components.[83]

Another issue specific to landfills is their tendency to shift and settle over time. Some of the landfills in MPCA's closed landfill program have dropped 15 to 20 feet in elevation since the 1990s.[84] Differential (i.e., uneven) settling is a much greater concern for solar installations on

[77] *Id.*; Telephone interview with Shawn Ruotsinoja, Land Manager, Closed Landfill Program, Minn. Pollution Control Agency (Apr. 8, 2015).
[78] Telephone interview with Doug Day, *supra* note 62.
[79] Telephone interview with Pete Pedersen, *supra* note 36 (explaining that closed landfill solar development in Massachusetts has been so successful that most of the best sites in the state are probably gone at this point). Doug Day explained that investors in a solar PV system on a closed landfill can benefit from substantial tax benefits for the first ten years of the system's life, after which they given the system to the landfill owner. Telephone interview with Doug Day, *supra* note 62.
[80] Telephone interview with Doug Day, *supra* note 62.
[81] BEST PRACTICES FOR SITING SOLAR PHOTOVOLTAICS, *supra* note 67, at 48.
[82] Telephone interview with John Paulson, *supra* note 69.
[83] BEST PRACTICES FOR SITING SOLAR PHOTOVOLTAICS, *supra* note 67, at 48.
[84] Telephone interview with Doug Day, *supra* note 62.

landfills than uniform settling.[85] Differential settling can alter array configurations, resulting in decreased energy production, and it may cause structural damage to the solar PV mounting system.[86] Solar developers tend to wait for at least two to three years before constructing arrays on a landfill, as recently closed sites may settle at a faster rate than older landfills, with settlement on older landfills eventually becoming negligible.[87] A settlement forecast can be conducted to project patterns of uniform and differential settlement, which developers can use to determine where to place the array, and what effect a PV system might have on future settlement.[88]

Choice of landfill cover can also help address uncertainty arising from differential settlement. The City of Hutchinson used clean granular fill and a fabric cover to make sure the weight of the PV system is distributed evenly across the top of the existing landfill cap.[89] A different and less common approach is to install a PV-integrated geomembrane, a solar power-generating landfill cover that is usually made of thermoplastic polyolefin material.[90] A geomembrane provides a number of benefits when applied to a closed landfill. Minor differential settlement does not impair its function; it can be repositioned to account for dramatic settling; and it can be cut, tightened, loosened, and repaired if it tears.[91] It is lightweight as compared to other anchoring systems, it is a good choice for steep slopes, and it replaces the traditional vegetative cover while costing about the same as that cover type.[92] Geomembranes also provide good landfill cover stability and reduce soil erosion, while decreasing water intrusion in the

[85] BEST PRACTICES FOR SITING SOLAR PHOTOVOLTAICS, *supra* note 67, at 26.
[86] *Id.*
[87] *Id.*
[88] *Id.* at 26-27.
[89] Telephone interview with John Paulson, *supra* note 69.
[90] BEST PRACTICES FOR SITING SOLAR PHOTOVOLTAICS, *supra* note 67, at 41.
[91] *Id.* at 38-39, 54.
[92] *Id.* at 38, 42, 48.

landfill cover.[93] One limitation of PV-integrated geomembranes is that they should ideally be installed on a landfill during closure, so it is less likely that a geomembrane would make sense for a landfill that is already closed.[94]

Dane County, Wisconsin is studying the feasibility of installing a geomembrane and flexible laminate solar panels on the steep south-facing slope at a county landfill.[95] The Wisconsin project should provide useful information to developers interested in using PV-integrated geomembranes on Minnesota landfills, as the two states have similar climates. Snow loading does not usually present a significant problem for geomembranes, but removal might be necessary if snow accumulation prevents the full function of the system.[96]

Conclusion

It is clear that developing renewable energy on contaminated land does not occur without challenges—whether they are the types of complications that normally arise during brownfield redevelopment or they are specific to energy projects. This paper has demonstrated, however, that there are good policy reasons for capitalizing on the solar resources that exist on contaminated land in Minnesota. While technical tools for managing liability are available, technological innovation and more regulatory and financial tools (which were beyond the scope of this paper) would help spur more solar development on contaminated land.

[93] *Id.* at 42.
[94] *Id.* at 48.
[95] Steven Verburg, *Dane County Hopes to Top Landfill with Thin, Flexible Solar Cap*, WIS. STATE J., Sept. 29, 2014, http://host.madison.com/news/local/environment/dane-county-hopes-to-top-landfill-with-thin-flexible-solar/article_63d7c391-e9ea-54bf-ad66-50fcf13f470b.html.
[96] BEST PRACTICES FOR SITING SOLAR PHOTOVOLTAICS, *supra* note 67, at 44.