



## Land Use and Renewable Energy Generation

Renewable energy offers the opportunity to transition away from fossil fuels and to combat the impacts of climate change, but careful consideration of the impacts of its development is critical to ensure the continued health of our precious landscapes.



Source: National Renewable Energy Laboratory

The land use issues associated with renewable energy generation differ from those of traditional energy generation. The most important contrast between the two types of generation is that polluting fossil fuels require tremendous land uses for their mining and transportation, which makes their overall impact far more destructive than the siting of renewable generation facilities. Nevertheless, environmental impacts associated with renewable energy development must be factored into siting decisions. Geothermal energy development poses many of the same surface and subsurface land impacts as oil and gas drilling; solar energy requires consideration of water use, surface disturbance, and habitat fragmentation; and wind development may involve the disruption of bird and bat migration corridors. By using best management practices, deploying distributed generation technologies, and ensuring full public involvement in the planning and siting processes, renewable energy technologies can be quickly deployed while our nation's precious public lands and habitats are simultaneously protected.

### **Distributed Generation**

Distributed generation is defined as the generation of energy close to the point of use.<sup>1</sup> These types of technologies can be small utilities serving parts of larger cities or entire small cities and towns. At the smallest extreme, distributed generation systems are installed on rooftops or on adjacent land, allowing property owners to generate electricity where it is used.

Distributed generation minimizes the amount of land required for development. Further, it does not require construction and maintenance of transmission infrastructure. For remote areas, places where electric grids are already at or near capacity, and in efforts to limit the cost and other impacts of constructing new long-distance transmission lines, the use of distributed

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<sup>1</sup> SolarBuzz. "Distributed Power Generation: compare solar energy with alternative energy sources." <http://www.solarbuzz.com/DistributedGeneration.htm>

generation may be very attractive. Other benefits of distributed generation include greater reliability, lower costs for consumers and reduced energy losses in transmission lines.<sup>2</sup>

A common distributed generation technology is solar photovoltaic (PV) panels. These panels can be attached directly to roofs and buildings and range from a few to over 500 kilowatts (kW).<sup>3</sup> Concentrated photovoltaic and concentrating solar power systems can also be used for distributed generation, with single units producing between 10 and 35 kW. Similarly, small wind turbines that generate up to 50 kW can be installed individually or in clusters.<sup>4</sup> These systems are frequently used by ranchers and farmers to pump water and generate electricity, and modern distributed wind systems can be equipped with battery storage that allows them to provide electricity even when there is little wind. Hybrid systems that combine wind and PV systems with each other also exist.



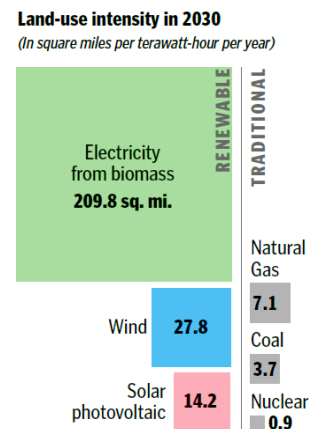
Source: National Renewable Energy Laboratory

Because of the land-use requirements and impacts of utility-scale generation, efforts to meet our energy needs and combat climate change should prioritize conservation, efficiency, and distributed generation as much as possible. However, because of economic and technological challenges, these strategies cannot stand alone. If aggressive greenhouse gas reduction goals are to be reached, utility-scale renewable energy generation must be a part of the solution as well.

### Utility-Scale Generation

Almost all of the nation’s electricity supply comes from central generation technologies, also known as “utility-scale” generation. Unlike distributed generation, this model generates a large amount of electricity inexpensively at a central power plant and transmits the power to users through a network of transmission cables—the grid.

Some utility-scale renewable energy plants have a larger footprint than coal or natural gas plants, as seen in the graphic to the right. However, it is important to note that unlike fossil fuels, renewable energy does not require the use of additional land for extraction, refining, and transportation of the fuel inputs. One estimate finds that in total over a 30-year period, a surface coal mine will use 21,844 acres of land while an average wind array will use 4,720 acres to produce the same amount of power.<sup>5</sup> But even though the land occupied by wind turbines can be used for other purposes such as farming and ranching, it still has a large and possibly fragmenting impact as generating facilities are spread across a large area.



Graphic (c) 2009, the Washington Post

<sup>2</sup> U.S. Department of Energy, Electricity Deliverability and Energy Reliability. “Distributed Energy Program.” <http://www.eere.energy.gov/de/>

<sup>3</sup> For reference, 1 MW = 1,000 KW

<sup>4</sup> U.S. Department of Energy. Distributed Energy Program. “Wind Power.” 2006. [http://www.eere.energy.gov/de/wind\\_power.html](http://www.eere.energy.gov/de/wind_power.html)

<sup>5</sup> Gipe, Paul. *Wind Energy Comes of Age*. John Wiley and Sons: 1995. page 395.

## Land impacts from utility-scale renewable energy generation

*Wind:* Construction and maintenance of turbines can affect the surrounding land by way of habitat fragmentation from roads and the footprint of the turbines, soil erosion from surface area disturbance, and potential pollution from runoff.<sup>6</sup> These effects can be mitigated by keeping the impacts on land to a minimum by using existing roads, reclaiming the topsoil once construction is finished and the use of standard erosion controls.<sup>7</sup>

*Solar:* Large-scale solar developments require landscape changes, as land must be graded to a slope of less than five percent<sup>8</sup> and all vegetation must be removed to reduce the risk of fire. The grading and clearing is particularly significant because of the large size of most proposed utility-scale solar plants. The removal of vegetation from such a large area could lead to the destruction and fragmentation of sensitive desert habitats, reinforcing the importance of prioritizing development in already degraded areas and full compliance with the National Environmental Policy Act, the Endangered Species Act and other environmental laws in all solar projects.

*Geothermal:* There are a number of environmental issues that the geothermal industry could pose to public lands. They require land for siting of the facilities and for drilling, and groundwater resources could be depleted or the water table lowered during drilling. Also, geothermal facilities emit some pollutants that are regulated under the Clean Air Act, including trace amounts of nitrogen oxides, sulfur dioxide, and carbon dioxide, though at very low levels.

## **Public Lands**

Interest in utility-scale renewable energy development on private, state and public lands in the U.S. has been increasing. Public lands can be an important part of our clean energy future, but care must be taken to ensure protection of our natural heritage along with renewable energy development. Wind development has occurred on both public and private lands, mostly in California and Wyoming, with over 300 megawatts (MW) currently installed on public lands.<sup>9</sup> Geothermal development on public lands has reached over 1,200 MW of installed capacity.<sup>10</sup> Solar development has thus far been confined to private lands; however, more than 200 applications for projects on public lands are pending.<sup>11</sup> It is important for the Bureau of Land Management to weigh the environmental costs and benefits when assessing the potential of any of these pending projects, by way of a full environmental review, a transparent public process and a thorough discussion of mitigation techniques. Further, the agency should prioritize areas

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<sup>6</sup> Bureau of Land Management Wind Programmatic Environmental Impact Statement. Chapter 5, pages 1, 5. <http://windeis.anl.gov/documents/fpeis/maintext/Vol1/Vol1Ch5.pdf>

<sup>7</sup> Ibid. Chapter 5, page 6.

<sup>8</sup> Western Governors' Association Western Renewable Energy Zones – Zone Identification and Technical Analysis Work Group. "Resource Criteria for Development of Candidate Study Areas." Page 9. <http://www.westgov.org/wga/initiatives/wrez/zita/ZITA%20TC%20criteria%20presentation.ppt>

<sup>9</sup> Bureau of Land Management. "Renewable Energy and the BLM: WND." January 2009.

[http://www.blm.gov/pgdata/etc/medialib/blm/wo/MINERALS\\_REALTY\\_AND\\_RESOURCE\\_PROTECTION\\_/energy.Par.58306.File.dat/09factsheetmap\\_Wind.pdf](http://www.blm.gov/pgdata/etc/medialib/blm/wo/MINERALS_REALTY_AND_RESOURCE_PROTECTION_/energy.Par.58306.File.dat/09factsheetmap_Wind.pdf)

<sup>10</sup> Bureau of Land Management. "Renewable Energy and the BLM: GEOTHERMAL.

[http://www.blm.gov/pgdata/etc/medialib/blm/wo/MINERALS\\_REALTY\\_AND\\_RESOURCE\\_PROTECTION\\_/energy.Par.69359.File.dat/09factsheetmap\\_Geothermal.pdf](http://www.blm.gov/pgdata/etc/medialib/blm/wo/MINERALS_REALTY_AND_RESOURCE_PROTECTION_/energy.Par.69359.File.dat/09factsheetmap_Geothermal.pdf)

<sup>11</sup> Bureau of Land Management. "Renewable Energy and the BLM: SOLAR."

[http://www.blm.gov/pgdata/etc/medialib/blm/wo/MINERALS\\_REALTY\\_AND\\_RESOURCE\\_PROTECTION\\_/energy.Par.78074.File.dat/09factsheetmap\\_Solar.pdf](http://www.blm.gov/pgdata/etc/medialib/blm/wo/MINERALS_REALTY_AND_RESOURCE_PROTECTION_/energy.Par.78074.File.dat/09factsheetmap_Solar.pdf)

for development which are already degraded, have limited wildlife and other resource conflicts, and are close to existing transmission and electricity demand.

### **Impaired Lands**

There is significant potential for renewable energy development on lands that have previously been used for other human purposes, including old industrial sites, former military bases, abandoned mines, and marginal agricultural land. The Environmental Protection Agency is currently conducting a survey of the renewable energy potential of almost 10,000 such sites, including Superfund sites, brownfields, and sites covered by the Resource Conservation and Recovery Act.



Former Bethlehem Steel site, now used for wind energy generation in Lakawanna, New York.  
Source: Environmental Protection Agency

Thousands of abandoned mine sites and state cleanup sites may also be appropriate for renewable energy development.<sup>12</sup> Renewable energy developers are already taking advantage of the potential for developing impaired lands for central renewable energy generation. First Wind, for example, constructed a 20 MW wind farm on a former industrial site once occupied by Bethlehem Steel in Lakawanna, New York, with plans to expand it to 45 MW by 2010. Using a former industrial site allowed First Wind to take advantage of existing transmission and transportation and to avoid the costs and environmental impacts associated with the construction of new infrastructure. Another example of a renewable energy development in a disturbed area is the Fort Carson Landfill Solar Development near Colorado Springs, Colorado, a 2 MW photovoltaic array built on 12 acres of a former landfill. The project generates about 3200 MWh/year and will power about 2% of Fort Carson's energy needs.<sup>13</sup> The project also won the Governor's Excellence in Renewable Energy Award for 2007.<sup>14</sup>

<sup>12</sup> See U.S. Environmental Protection Agency. "RE-Powering America's Land: Renewable Energy on Contaminated Land and Mining Sites." <http://www.epa.gov/renewableenergyland/>

<sup>13</sup> United States Army Environmental Command. "Solar Power Array Constructed on Fort Carson Landfill." <http://aec.army.mil/usaec/newsroom/update/win08/win0812.html>

<sup>14</sup> U.S. Department of Energy. "Colorado Bestows Renewable Energy Awards, Celebrates Biofuels Milestone." [http://apps1.eere.energy.gov/state\\_energy\\_program/project\\_brief\\_detail.cfm/pb\\_id=1243](http://apps1.eere.energy.gov/state_energy_program/project_brief_detail.cfm/pb_id=1243)

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