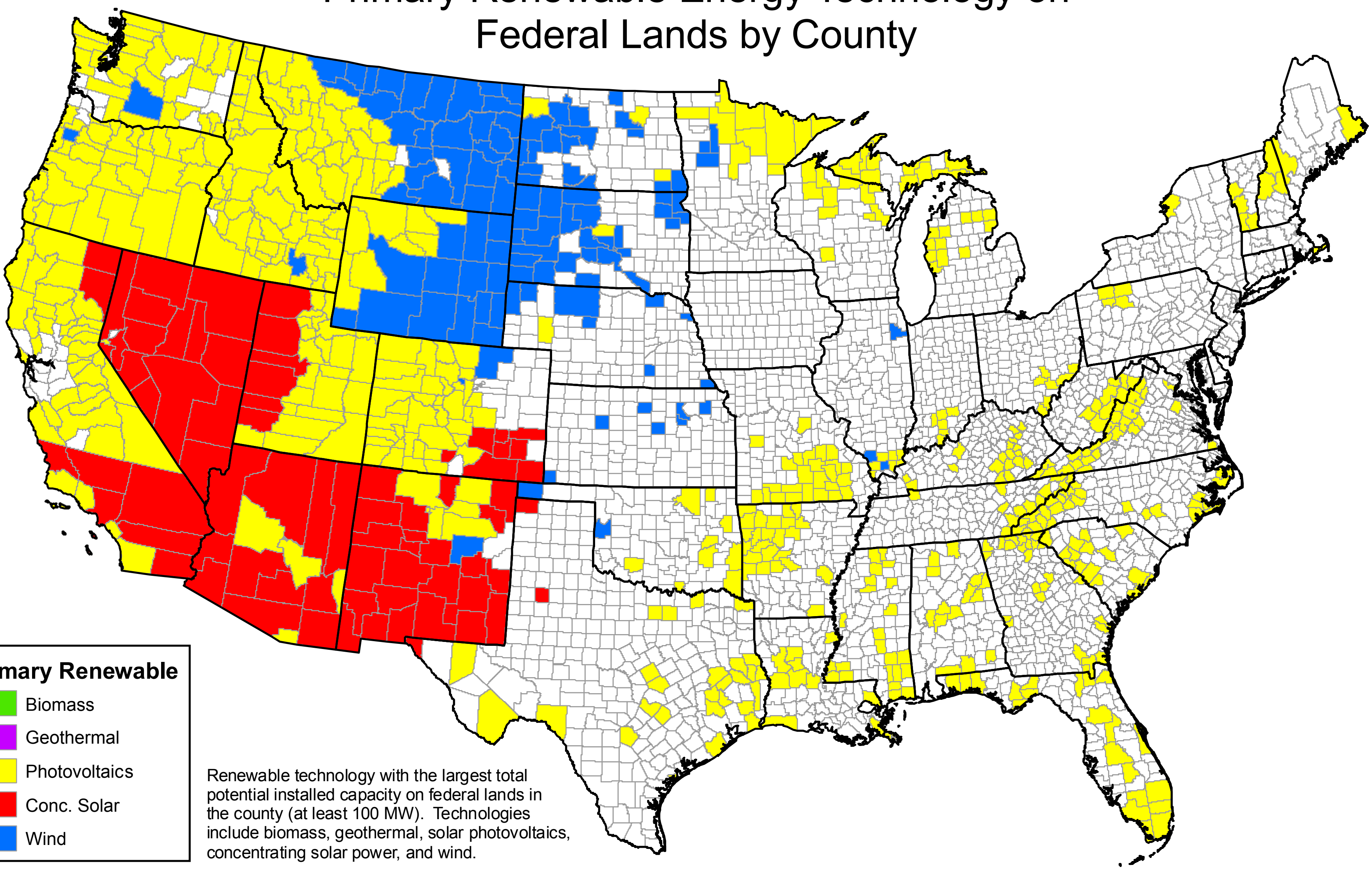
# Primary Renewable Energy Technology on Federal Lands by County



**Primary Renewable**

- Biomass
- Geothermal
- Photovoltaics
- Conc. Solar
- Wind

Renewable technology with the largest total potential installed capacity on federal lands in the county (at least 100 MW). Technologies include biomass, geothermal, solar photovoltaics, concentrating solar power, and wind.

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**Prepared Statement of**
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Mr. Chairman, thank you for this opportunity to discuss energy development on public lands and the Outer Continental Shelf. I am the director of the National Renewable Energy Laboratory, the Department of Energy's primary laboratory for research and development of renewable energy and energy efficiency technologies.

As our nation moves toward a clean energy future, it is becoming increasingly clear that federal lands are one of the keys to realizing the true potential of our vast array of renewable energy resources. Wind, solar, biomass, geothermal, water and ocean energy resources are in abundance across the nation's millions of acres of federal lands and offshore regions. While the immense clean energy potential of public lands is clear, much work remains to fully characterize each of the resources contained therein, to identify the optimum sites and timeframes for deployment, and to put in place the best systems for making these lands available for commercial development.

## Resource Potential on Public Lands

As part of my testimony, I have provided the Committee with maps our Laboratory has assembled which graphically show the renewable energy resource potential of public lands. These maps detail the resource potential on a county-by-county basis. At this stage, the maps do not account for variable factors such as development cost, access and existing land use applications.

If we take the overall renewable resource potential on public lands in the 48 Continental states, and we assume that 10 percent of it could be developed, the possible contribution to the nation's energy needs is significant. For photovoltaic (PV) solar, 10 percent development of resource potential is estimated at 140 GW; concentrating solar power (CSP), 400 GW; wind power, 80 GW; and, biomass, (forest and primary mill residues only), .3 GW. For geothermal we considered only known, suitable development sites, and found a potential for 20 GW. (See technical notes following this text for a detailed explanation of methodology).

Considering the collective potential of all of these renewable energy resources, again assuming 10 percent development of wind, solar and biomass, and 100 percent development of known geothermal, we found a potential contribution of approximately 640 GW. One caveat to keep in mind is that wind and solar are intermittent, and thus produce less energy over time than their full generation capacity would suggest.

However, given that total U.S. electrical generation capacity is 1,088 GW, you can begin to see the significance of renewable resources on public lands.

Most all federal land areas have some renewable energy potential; many areas can support multiple renewable technologies. The resource potential on federal lands is concentrated in Western states, where the bulk of federal lands are located. Concentrating solar power dominates in the southwest; wind in the upper Great Plains, and photovoltaics in the remainder of federal lands. For geothermal, the best quantifiable information is available for specific sites that have been evaluated; the total geothermal potential may be significantly larger than these existing figures suggest.

When the potential for federal lands to contribute to our nation's transportation fuel needs is considered, we found that the leftover residue material from logging and milling operations could produce enough cellulosic ethanol to displace 8% of gasoline consumption. This assessment does not include harvesting of standing trees for energy use; also excluded are the extensive resources that might be available as a result of pine-beetle devastation throughout forests in western North America. Cellulosic ethanol technology is still under development.

Other national assessments of renewable energy potential likewise envision a major role for public lands. The 20% Wind Scenario developed by NREL and DOE is the most comprehensive accounting of the longer term potential for wind power in the U.S. Of the 300 GW that were projected to be needed to meet the 20 percent threshold of U.S. electricity needs in 2030, the study found that 54 GW would come from offshore wind. Another 33 GW is projected from wind farms located on public lands onshore.

As federal land agencies gear up to meet the nation's demands for renewable energy, they will be confronted with new issues from the emerging wind, solar, and other renewable industries. The sensitive economic drivers of the wind power industry, for example, are fundamentally different than those of the oil and gas industry, which has a long history of leasing and resource development on federal lands. That fact is further complicated by the varying levels of maturity for each of the respective renewable technologies, and the disparate costs of energy produced by each.

Any process for permitting renewable energy development and electric transmission projects on public lands should have at its heart the twin goals of finding sites where the most economical renewable resources can be developed, with the least harm to the environment. The quality and cost of wind, solar, geothermal, and other renewable resources varies geographically, as does the fragileness of terrain and wildlife habitat. Balancing the two requires a transparent, public dialogue between federal land managers, private land owners, environmental interests, industry, state authorities and technical experts.

Federal lands in particular are expected to have a major role in the transmission of electricity from remote wind, solar and geothermal projects to the nation's population centers. Regional planning and consideration of the economies of scale are essential factors in routing transmission lines across federal lands. One super-sized transmission line poses less harm and delivers more benefit than a proliferation of smaller lines.

Targeting a multi-billion dollar investment in a major transmission corridor requires careful planning because it needs to mesh with the grid that is already serving customers throughout the region. This comprehensive planning process needs to locate concentrations of high-quality renewable resources, identify the demand centers that will receive the power, and ensure that both can be connected in a way that maintains essential grid reliability. A broad consensus early on about where transmission lines should go will reduce the potential for delay and litigation later, when specific lines are reviewed.

**Barriers to Development**

Unduly burdensome fees and regulations in a leasing program could stifle development of the very clean energy resources that we as a nation are striving to encourage. It is essential that the unique economic and business considerations that are fundamental to the successful development of renewable resources are fully understood, and reflected in the leasing procedures and regulations for public lands.

The pending rules by the Minerals Management Service regarding leasing of offshore resources are designed to be conducive to our broader federal energy goals. The American Wind Energy Association and the Ocean Renewable Energy Coalition submitted extensive comments on the proposed MMS rules; NREL, in its role to support the growth of renewable energy industries, has reviewed and generally supports these recommendations.

Within those recommendations are some useful, broader principles for guiding future renewable energy access programs for public lands. To ensure timely development, the process should first and foremost minimize any opportunity for administrative delay and have in place workable timelines for project approvals. The process should also safeguard against misuse of the leasing system. Land management agencies should work with regional transmission planning entities, utilities and state regulators to ensure that federal leases for renewable energy development are awarded to those who are likely to build wind, solar or other renewable generation capacity, and not to those who intend to artificially increase the cost or limit the development of renewable resources by withholding their leased federal lands from development.

Finally, revenue collection mechanisms in the process should be structured in ways that protect the federal treasury, without deterring publicly beneficial renewable energy projects.

A related area of importance is the need for R&D sites in the field for testing marine energy systems. Separate and distinct from the commercial leasing program, such sites could be utilized for testing offshore wind turbines, wave energy systems and ocean current turbines. We urge that such a program be created in the near term to facilitate expected needs for prototype testing of new ocean energy systems.

Some history is in order to explain how the renewable energy development program has evolved for public lands. In July of 2002, the Bureau of Land Management, DOE Golden Field Office and NREL signed an agreement to begin joint work on renewable energy technology expertise and project development on public lands.

A year later, NREL completed the study, "Assessing the Potential for Renewable Energy on Public Lands," for BLM, which covered solar, concentrating solar power and photovoltaics, wind and biomass (http://www.nrel.gov/docs/fy03osti/33530.pdf). BLM's initial objective was to identify the BLM lands with the highest renewable resource potential, and to begin prioritizing and planning renewable energy development in those areas. One unexpected result of that study was a dramatic surge in the number of wind industry Right-of-Way (ROW) applications to BLM Field Offices in Western states for wind farm development on public lands.

In response to the flood of wind industry applications, BLM worked with NREL and the wind industry to develop a first-of-its-kind application process. The result, in October of 2003, was the BLM Wind Development Policy Memorandum, which guides BLM Field Offices regarding wind industry applications.

To date, more than 70 wind project development applications have been approved for wind resource monitoring, and several applicants have moved forward with development plans and environmental studies for commercial scale wind farm development. Of particular note is the proposed 2000-2500 MW wind farm planned near Rawlins, WY.

In 2004, BLM began work with NREL to develop solar development policies for public lands, similar to those developed for wind power. Those policies were released in October, 2004. So far, BLM has received more than 200 applications for solar power project development, in California, Nevada, Arizona, New Mexico and Colorado. Typical projects are in the 400 MW-500 MW range.

A significant challenge for both BLM and renewable energy industry applicants is the time and cost of the compliance requirements in the National Environmental Policy Act. An Environmental Impact Statement and other compliance procedures can cost applicants more than $1 million and take 18 months or more to complete.

To support the renewable industry and its own field offices, BLM engaged NREL and Argonne National Laboratory to develop a Wind Programmatic EIS (PEIS), which analyzes the environmental impacts of wind development in 11 Western states. The Wind PEIS was completed in June 2005 and adopted by the BLM as a way to streamline the permitting process. Currently, NREL and Argonne are helping develop a joint BLM-DOE solar Programmatic EIS, scheduled for completion in late 2010. The Solar PEIS, like that for wind power, is planned to be adopted by BLM Field Offices to support solar power plant development.

To overcome the limited experience BLM field offices have had with renewable energy technology, the agency has contracted with NREL for technical support with wind and solar development inquires, and for BLM staff training on wind and solar technology and development issues.

DOE and the Interior Department recently began a joint effort to accelerate the processing of solar applications on BLM lands in the Southwest. Additionally, the DOE Solar Program has launched an effort with NREL and Sandia National Laboratories to deliver technology expertise and technical support to BLM Field Offices to handle energy land leases in light of the energy tax and investment provisions in the American Recovery and Reinvestment Act.

As for renewable energy on federal lands beyond those controlled by BLM, NREL conducted a study for USDA-USFS, "Assessing the Potential for Renewable Energy on National Forest Service Lands," January 2005. (www.nrel.gov/docs/fy05osti/36759.pdf) NREL also conducted a study for DOE's Office of Legacy Management, "Assessing the Potential for Renewable

Energy Development on DOE Legacy Management Lands," February 2008. www.lm.doe.gov/documents/NREL41673.pdf

**A Coordinated Approach**

One point that cannot be underestimated is the need for a robust, multi-dimensional, and multi-agency federal approach to renewable energy development on public lands. A good example of cooperative efforts is the Solar Reserve Pilot Project, which is included in Senate Bill 539. This provision calls upon the Energy Department, the Department of Interior and other relevant agencies to work together to site and facilitate utility scale solar power projects on federal lands.

**The Role of R&D**

The need for ongoing technology refinements likewise is crucial. The wind industry, for instance, will not be able to avail itself of new offshore opportunities without the development of the new technologies, systems and concepts that will be required to operate in the marine environment.

Cost also is a determining factor for renewable energy technologies. Each of the renewable energy industries places a major emphasis on continuing efforts to reduce the costs of their commercial products, so they can compete on an even playing field with conventional energy systems. Of course, reducing the cost and increasing the efficiency of these technologies is the primary focus of NREL and the DOE programs it supports.

Some of the necessary reductions in costs will come as a result of the economies of scale that are achieved as these industries mature, and grow into higher levels of manufacturing and production. Even so, much of the cost and efficiency gains that are still needed can only come from innovation, and that innovation can only come from an ongoing commitment to research and development.

Continuing R&D by federal research institutions, universities and private sector is crucial to the long term, successful build-out of renewable energy systems on public lands, as it is for clean energy deployment generally.

And while renewable energy industries have enjoyed considerable growth in recent years, there remains a lot of room for technology improvement. The increasing size of wind turbines well illustrates the point. As wind turbine manufacturers seek to capture maximum efficiencies, the size of the machines continues to grow. Where turbines under 1 MW dominated the market only a few years ago, machines in the 1.5 MW to 3 MW range are today the dominant force. With attention turning to the unique opportunities presented by offshore wind resources, there are now even proposals for 10 MW turbines.

Conceptually, these giant turbines could undercut the dramatically increased costs of placing supporting structures in the ocean, by greatly increasing the power produced by each turbine. The problem that exists today is that there is no commercial pathway to producing a 10 MW wind turbine, and many industry observers say it won't happen at all without a serious new commitment to research and development. We believe it will be possible to produce turbine blades nearly two football fields across, like those required of a 10 MW machine, but we don't know how to do it today.

Ongoing innovation for increased efficiency and lower energy costs is essential if we are to fulfill the promise of other renewable technologies as well.

For wind, solar, geothermal and other industries, it will be the second and third generations of technology that will ultimately boost deployment to the speed and scale the nation needs to meet our long term clean energy goals on federal lands, and beyond.

**Technical Details of NREL Calculations for Renewable Resource Potential on Public Lands**

1. PV potential calculated with no exclusions. Installed capacity estimated assuming 10% coverage by PV systems with a 10% conversion efficiency. Solar resource data is 2007 NSRDB/SUNY satellite modeled data for 1998-2005, fixed flat plate with tilt = latitude.
2. CSP potential calculated with exclusions in the southwestern U.S. only; eliminating areas with slope >1%; federal protected lands including parks, wilderness areas and wildlife refuges; urban, wetland and water features; resource areas <6.0 $kWh/m^2/yr$; and remaining areas <1$km^2$ in size. Installed capacity estimated assuming 50 $MW/km^2$. Solar resource data used is 2007 NSRDB/SUNY satellite modeled data for 1998-2005, direct normal solar radiation.
3. Wind potential calculated with standard exclusions: federal protected lands including parks, wilderness areas and wildlife refuges; urban, wetland and water features; a 3 km area surrounding all of those excluded areas except water; exclusion of 50% of the remaining U.S. Forest Service and Dept. of Defense lands; exclusion of 50% of non-ridgecrest forested areas; and exclusion of areas with slope >20%. Note 50% exclusions are applied only once to a given area, they are not cumulative. Installed capacity estimated assuming 5 $MW/km^2$. The wind resource data used was that produced for the 20% Wind Vision Report.
4. Biomass potential calculations used installed capacity estimates assuming 1 dry ton/hr/MW (20% efficiency industry average). Biomass data from *Geographic Perspective on the Current Biomass Resource Availability in the United State* (Milbrandt, 2005).
5. Geothermal potential (hydrothermal and convective EGS) calculated with no exclusions. Installed capacity estimated for each individual location, accounting for already developed capacity. Geothermal resource data used was provided by Gian Porro in Jan 2008 (Site Geothermal Data - Hydro and Conv EGS - Tech Potential.xls).