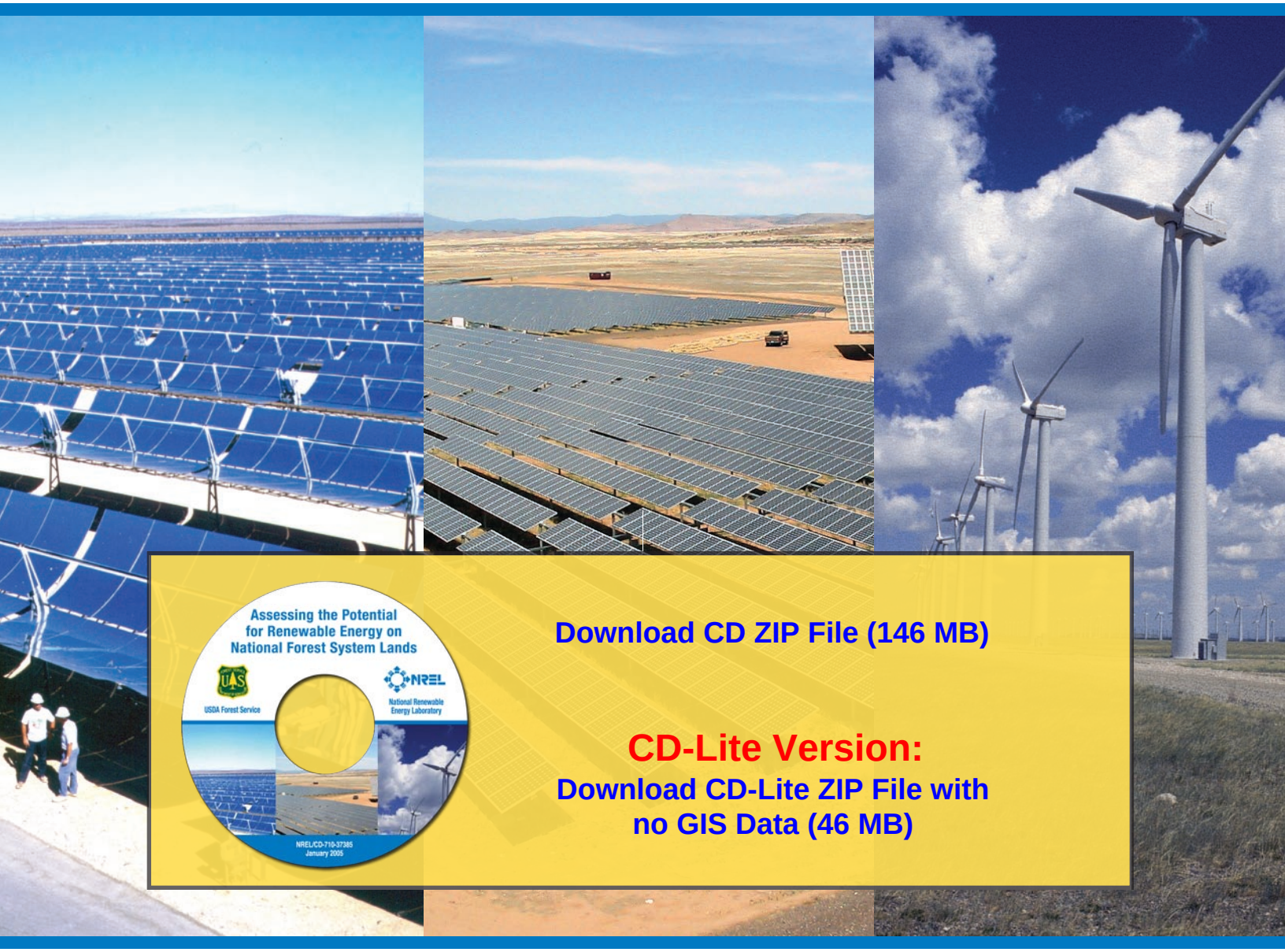
Assessing the Potential for Renewable Energy on National Forest System Lands -



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COVER PHOTOS (left to right): World's largest solar power facility (PIX 11070, Kramer Junction Company); Arizona Public Service 2-Megawatt PV Facility (PIX 13338, Arizona Public Service); Wyoming Wind Farm (PIX 11568, Eugene Water and Electric Board).

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The primary authors of this report are Randy Karsteadt (Rocky Mountain Region, Director of Physical Resources, and formerly Washington Office, Special Uses Program Leader); Doug Dahle, project leader (Federal Energy Management Program, NREL); Donna Heimiller (Electric and Hydrogen Technologies and Systems Center, Resource Integration Group, NREL); and Teresa Nealon (Federal Energy Management Program, NREL). And we thank the following NREL staff members for their contributions:

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Executive Summary

This report represents an important initial activity of the U.S. Department of Agriculture, Forest Service (USFS), to identify and evaluate the potential for solar and wind energy resource development on National Forest System (NFS) public lands, including administrative and physical limitations on access to them. Ultimately, USFS should find this information valuable in making land management decisions that include consideration of the potential for industry development and use of solar and wind energy resources on NFS lands.

To accomplish this task, USFS and the U.S. Department of Energy's National Renewable Energy Laboratory (NREL) established a partnership to conduct an assessment of solar and wind energy resources on NFS lands in the continental United States. The objective of this collaboration was to identify those National Forest and Grassland units that likely have the highest potential for private-sector development of solar and wind energy resources.

The USFS/NREL team used Geographic Information System (GIS) data to analyze and assess the potential for concentrating solar power (CSP), photovoltaics (PV), and wind resources and technologies on public lands. USFS, NREL, and industry representatives jointly developed screening criteria for each of these solar and wind resources to produce GIS-based maps and analyses. The team identified the top 25 National Forest System Units with areas having the highest potential for CSP, PV, and wind.

The assessment resulted in the following findings:

- Ninety-nine National Forest Units have high potential for power production from one or more of these solar and wind energy sources

- Twenty National Forest Units in nine states have high potential for power production from two or more of these solar and wind energy sources.

This assessment report provides USFS with information needed to include in its land and resource management decisions for consideration of the potential for solar and wind energy development on NFS lands.

Definitions

BEF	Bonneville Environmental Foundation
BLM	Bureau of Land Management
B&O	Business and Operation Tax
CEC	California Energy Commission
CSP	Concentrating Solar Power
CSR	Climatological Solar Radiation Model
DEM	Digital Elevation Model
DOD	U.S. Department of Defense
DOE	U.S. Department of Energy
DOI	U.S. Department of Interior
EERE	DOE Office of Energy Efficiency and Renewable Energy
EILP	Energy Improvements Loan Program
EPS	Environmental Portfolio Standard
ESCO	Energy Services Companies
IEEE	Institute of Electrical and Electronic Engineers
IOU	Investor-owned Utilities
GIS	Geographic Information Service
MACRS	Modified Accelerated Cost Recovery System
NEC	National Electric Code
NFS	National Forest Service
NREL	National Renewable Energy Laboratory
NWTC	National Wind Technology Center, NREL
PEIS	Programmatic Environmental Impact Statement
PRC	Public Regulation Commission
PSB	Public Service Board
PSC	Public Service Commission
PTB	Price to Beat
PUC	Public Utility Commission
PV	Photovoltaic
R&D	Research and Development
REC	Renewable Energy Credits

REP	Retail Electric Providers
ROW	Right-of-Way
RPS	Renewable Portfolio Standard
SELP	Small-scale Energy Loan Program
TDU	Transmission and Distribution Utility
TOU	Time of Use
UL	Underwriters Laboratory
USDA	U.S. Department of Agriculture
USFS	U.S. Forest Service

Assessing the Potential for Renewable Energy on National Forest System Lands

1. Objective

The U.S. Department of Agriculture, Forest Service's (USFS) intent to identify the contribution that National Forest System (NFS) lands can make to increasing the production of domestic energy resources through solar and wind energy development is consistent with the provisions of the National Energy Policy. Such an exercise begins with an assessment of the solar and wind resource potential. This assessment has a two-part objective:

1. To assess the potential for solar and wind energy on NFS lands and
2. To identify National Forest and Grasslands units in the NFS that have the highest potential for development by industry of power production facilities based on solar and wind energy.

This report provides information to the USFS, the public, and industry to focus interest in NFS lands for solar and wind energy development on those areas with high potential.

2. Scope

This solar and wind resource assessment addresses National Forest and Grassland units in the United States, except Alaska. Alaska was not included because of the lack of transmission system data in Geographic Information System (GIS) format, a critical element used for screening high-potential areas for solar and wind energy development. The solar and wind energy sources and technologies addressed in this report include concentrating solar power (CSP), photovoltaics (PV), and wind. Included is a CD-ROM of the report in PDF format, releasable GIS data used in the analysis, PowerPoint files of all GIS maps for each solar and wind resource analyzed, and Excel files for all tables cited in this report containing lists of NFS Units with the highest potential for solar and wind energy (Tables 1a-1c, 2, C-1A – C, and C-2).

3. Background

This USFS assessment of the potential for renewable-energy power-production facilities on NFS lands is consistent with the principal national policy objective to address access limitations to federal lands to increase solar and wind energy production from domestic solar and wind resources.

The need for this assessment of the potential for solar and wind energy power production was also identified as an outcome of the National Conference on Opportunities to Expand Renewable Energy on Public Lands, hosted by the U.S. Department of the Interior (DOI) and the U.S. Department of Energy (DOE) in November 2001 in Washington, D.C. The conference was chaired by the Department of Interior (DOI) Secretary, Honorable Gale Norton, and the DOE Assistant Secretary for Energy Efficiency and Renewable Energy, David Garman, representing Energy Secretary Spencer Abraham.

Representatives from the U.S Department of Agriculture (USDA), the Environmental Protection Agency (EPA), the Department of Defense (DOD), the Council on Environmental Quality, and the Federal Energy Regulatory Commission also attended. Attendees heard testimony from

industry on issues related to the development of power from geothermal, wind, solar, biomass, and hydropower resources on federal lands.

USFS interest in pursuing this solar and wind resource assessment is also based on the demonstrated high value of the solar and wind resource potential analysis and report developed by the DOE Office of Energy Efficiency and Renewable Energy (EERE) and the National Renewable Energy Laboratory (NREL) for the Bureau of Land Management (BLM). The report is entitled, "Assessing the Potential for Renewable Energy on Public Lands" (http://www.nrel.gov/docs/fy03osti/33530.pdf).

Action

The USFS will consider potential for solar and wind energy development in National Forests and Grasslands, as appropriate, in land management decisions, and in making decisions in response to solar and wind energy exploration and development proposals that require the use and occupancy of NFS lands. The assessments provide valuable and much needed information. The assessments enhance the proper evaluation of solar and wind energy development and will be reviewed during all applicable land and resource management decision making.

Method

The assessment used data readily available from DOE and other sources, as well as appropriate screens related to such matters as transmission facilities and markets.

Tasks

Four tasks were accomplished in assessing the potential for solar and wind power production on NFS lands:

1. Gathering of available information on solar and wind energy potential
2. Developing appropriate screening criteria
3. Compiling data identifying National Forest units that have high potential for solar and wind energy development
4. Documenting high-potential areas in the final report.

Most solar and wind energy uses of NFS lands can occur in a manner consistent with existing resource management plans. Applicants may apply for an authorization under the appropriate authority at any time. These existing forest plans identify Specially Designated Areas (which include, but are not limited to, Wild and Scenic River Corridors, wilderness areas, wildlife areas, etc.), Inventoried Roadless Areas, and other specially designated management areas where land management objectives may preclude, or restrict a variety of uses, including solar and wind energy projects. This assessment will address and identify NFS lands that will be excluded from solar and wind energy development. Therefore, one possible use of this report may be to assist USFS in identifying NFS lands with the highest potential for the development of solar and wind energy resources. While the final assessment results will not reprioritize the order of plan revisions or amendments, it will provide planners with (1) more information to consider and (2) opportunity to address solar and wind energy potential in plan amendments and revisions. Where forest plans acknowledge areas having a high potential for solar and wind energy

development, the procedures needed to process subsequent special-use applications for solar and wind energy exploration and development can often be streamlined.

4. The Approach for Assessing Solar and Wind Energy Potential

Task 1. Gather Available Information on Solar and Wind Energy Potential

USFS staff from the Forest Service Geospatial Service and Technology Center in Salt Lake City, Utah, provided NREL with GIS-based data of Forest Service land boundaries, Specially Designated Areas, and Inventoried Roadless Areas. NREL's GIS team then produced GIS maps illustrating solar and wind energy resources, with an overlay of USFS National Forest and Grassland units. Maps for CSP, PV, and Wind are provided in Appendix C. Renewable resource and USFS land ownership GIS data descriptions are provided in Appendix B. NREL resource data for solar (CSP and PV), and wind energy were deemed suitable for a regional-scale analysis, but more detailed data are necessary for site-specific applications. Descriptions of the resource data sets used in the analysis are as follows.

Solar

NREL has developed a national solar resource assessment for the United States at a resolution of approximately 40 km by 40 km. These data are updated periodically. The most recent update was in 2001 and represents 14 solar collector configurations. The data were developed using NREL's Climatological Solar Radiation Model. A higher resolution regional solar resource assessment was developed by the State University of New York with input from NREL. This assessment covers the southwestern United States at a 10 km by 10 km resolution. The higher resolution data was used where available. Appendix B describes the solar data in further detail.

CSP

The CSP analysis used direct normal solar data. These data are pertinent to concentrating systems that track the sun throughout the day, such as trough collectors or dishes.

PV

The PV analysis used data for a 1-axis tracking flat plate collector with 0 degrees of tilt. These trackers pivot on their single axis to track the sun, facing east in the morning and west in the afternoon.

Wind

A low-resolution (~625 km^2) United States wind resource assessment was produced in 1987. Since then, NREL and other organizations have produced updated higher resolution (0.04 to 1 km^2) wind resource assessments that better reflect the effects of terrain on the potential wind resource. The low-resolution wind data captured continental wind patterns. However, the coarse scale meant that the assigned wind resource could apply to as little as 5% of the area if, for example, good resources were on ridge crests. Higher resolution digital terrain data allow the updated wind resource assessments to more accurately depict ridge lines and the effects of blocking on potential wind resources. These data also produce a more accurate overall picture of the distribution of the wind resource. However, the updated assessments are model-derived data

and not a substitute for on-site measurements before actual site development, even with the large increase in resolution.

NREL has completed and validated updated assessments for Arizona, California, Colorado, Connecticut, Delaware, Idaho, Illinois, Maine, Maryland, Massachusetts, Montana, Nevada, New Hampshire, New Jersey, New Mexico, North Carolina, North Dakota, Oregon, Pennsylvania, Rhode Island, South Dakota, Utah, Vermont, Virginia, Washington, West Virginia, and Wyoming. Additional states assessments are underway by NREL, and several additional states will be complete by the time this report is published. Information on updated wind resource assessments is available at http://www.windpoweringamerica.gov.

For this analysis, the updated NREL assessments were used when completed, and the 1987 assessment was used for the rest of the states. Appendix B describes the solar and wind data in further detail.

USFS-Specific and Other Data

USFS Geospatial Service and Technology Center staff provided detailed GIS data on areas that should be excluded from development (specially designated areas such as wilderness areas and wildlife areas and inventoried roadless areas) on USFS lands and National Forest unit boundaries in the lower 48 states. Other data used in the analysis included topographical data and data on transmission lines, major roads, and railroads. For more information on data sources, see Appendix B.

Task 2. Development of Appropriate Screens

USFS and NREL staff held meetings on CSP, PV, and wind to develop screening criteria for GIS analysis and characterization of the potential for solar and wind power production. The objective of each screening criteria development meeting was to identify any criteria that impact the economic and technical feasibility of solar and wind power production. The list of criteria was then evaluated for its ability to be used in GIS mapping, and GIS data availability and sources were discussed. Finally, the top six most significant criteria in targeting high-potential solar and wind power opportunities were selected for Task 3 (for CSP, PV, and wind).

Solar-CSP Screening Criteria Development Meeting

On January 22, 2004, the USFS/NREL team met to develop a list of high-potential site screening criteria. The following were identified as the most important screening criteria (in order of importance).

Central Generation Technology Criteria

1. Solar resource is at least 5 kWh/m^2/day of direct normal radiation and ideally greater than 7 kWh/m^2/day
2. Slope of land area at the site must be less than 5% and ideally less than 1%
3. Transmission access is within 25 miles (69-345 kV), and transmission capacity is available
4. Forty acres is the minimum parcel size
5. Site must have access to graded roads or rail within 25 miles
6. Exclusionary areas include Inventoried Roadless Areas and other Specially Designated Areas

Distributed Generation Technology Criteria

1. Solar resource is 5 kWh/m^2/day of direct normal
2. Slope of land area at the site must be less than 10%
3. Site must have access to graded roads or rail within 25 miles
4. Exclusionary areas include Inventoried Roadless Areas and other Specially Designated Areas

The following items were also identified by the meeting participants. But they were not identified as the most important screening criteria.

Central Generation Technology Criteria

- Site must have a low average wind speed (average wind speed < 10 miles/hour)
- Water resources must be available
- Site should be within 25 miles of a main natural gas pipeline for some configurations
- Some vegetation at the site must be removed
- Federal, state, and local policies are supportive
- Site must allow structures 15-50 feet high. Some technologies could require structures hundreds of feet tall
- Livestock protection is possible.
- Light reflection at sites near major roads could be an issue for some technologies
- A population center should be within 100 miles
- Assess visual resource management on a case-by case basis

Distributed Generation Criteria

- The site is within 100 miles of a population center
- Transmission access, water availability, and minimum parcel size are not an issue

Solar–PV Screening Criteria Development Meeting

On January 22, 2004, the USFS/NREL team met to develop a well-defined list of screening criteria. The following items were identified as the most important screening criteria (in order of importance).

Central Station Technologies for GIS Analysis

1. Solar resource availability is at least 5 kWh/m^2/day and favorable to large-scale PV. Ideally solar resource availability would be 7 kWh/m^2/day or greater.
2. Slope of land area at site must be less than 5% and ideally less than 1%
3. Forty acres is the minimum parcel size
4. Site must have access to graded road or rail within 25 miles
5. Transmission access is within 25 miles (69-345 kV) and transmission capacity is available
6. Exclusionary areas include Inventoried Roadless Areas and other Specially Designated Areas

Distributed Generation and Small-Scale Technologies for GIS Analysis

1. Full cost of competing power (production, transmission and distribution [T&D], environmental costs, etc.) is known and favorable to PV
2. Current fuel use at the site (especially unpowered and diesel-powered sites) is known and favors PV
3. Water access is available, which is important for water-pumping applications
4. Grazing sites are good small-scale applications
5. Existing and planned recreation areas are good for remote applications
6. Exclusionary areas include Inventoried Roadless Areas and other Specially Designated Areas

The following items were also identified by the meeting participants, but they were not identified as the most important screening criteria.

- Cost of environmental impacts of existing infrastructure is favorable to PV
- Cost of maintaining existing energy infrastructure is favorable
- High or unique environmental standards exist in the region
- Cost of a site-specific environmental assessment is favorable
- Security must be considered
- Road access is needed for construction equipment
- Extending transmission is needed in some cases for large-scale PV systems
- Projected growth in the region is known, if supplying additional energy

- Local utilities and peak unit power production costs should be considered
- Visual resource impacts need to be assessed on a case-by-case basis
- Full cost of competing power (production, T&D, environmental costs, etc.) is known and favorable to PV
- Electric power regulatory regime (want retail access) is favorable to PV
- Federal, state, and local policies are supportive

Wind Screening Criteria Development Meeting

On January 23, 2004, the USFS/NREL team and a selected member of the wind-energy community at the National Wind Technology Center (NWTC) to develop a well-defined list of screening criteria. The following items were identified as the most important screening criteria (in order of importance):

1. Wind resource is wind power Class 4 and above for short term, Class 3 and above for long term
2. Transmission access is within 25 miles (69-345 kV) and transmission capacity is available
3. Site must have access to graded roads within 25 miles
4. Exclusionary areas include Inventoried Roadless Areas and other Specially Designated Areas
5. Site is not within 3 km of an urban area
6. Slope of land area is a 20% grade (maximum) or less.

The following items were also identified by the meeting participants, but were not identified as the most important screening criteria:

- Ease of permitting and siting should be considered, including siting in a manner that minimizes or mitigates impacts to visual resources, noise, avian species, etc.
- Regional market conditions are critical (e.g., electricity rates, load growth, reserve margins)
- Site is within 50 miles of an urban area for operations and maintenance considerations
- Turbine array densities that produce 5-7 megawatts (MW) per square kilometer are typical. Projects are known to require up to 10 square miles, with at least 1 square mile necessary
- Visual resource impacts need to be assessed on a case-by-case basis
- Federal, state, and local policies support wind energy
- Proximity to load centers or transmission lines connected to load center, with available capacity required.

Task 3. Compilation of Data Identifying Broad Geographical Areas as High Potential for Solar and Wind Energy Development

This task ultimately focused on processing GIS data to identify high-potential areas for solar and wind energy development. A Geographical Information System (GIS) is a computer-based system used to manipulate, manage, and analyze multidisciplinary geographic and related attribute data. All the information in a GIS is linked to a spatial reference system used to store and access the data. GIS data layers can be recombined, manipulated, and analyzed with other layers of information to identify relationships between features, within a common layer or across layers.

This analysis was conducted on a regional scale, and the results are suitable for use at the National Forest unit level. On-site measurement and analysis are recommended before the development of any facilities, but this analysis should be useful in refining the prospecting process of site identification.

Initial meetings held to develop technology-screening criteria identified several categories of GIS data to be used in the screening process. Unfortunately, the GIS data needed to implement several of the screening criteria were not available or could not be fully implemented in the limited amount of time available for this analysis. In particular, one constraint was mentioned in each technology meeting: transmission line congestion and availability. Detailed data are available, but they are not in a spatially referenced format. Several other data sets were not available at the regional scale with the level of informational detail that participants wanted, but they were deemed adequate given the regional nature of the analysis.

The transmission line data set covers the contiguous United States and is generally complete down to 100 kV. NREL staff thought that lines with lower voltages would be suitable for development, but a consistent nationwide database for lower voltage lines could not be located.

The screening criteria applied to each technology are described below and results shown in Figures 1 through 3. All GIS maps showing criteria and final results are in Appendix A.

CSP

1. Direct solar resource is 5 kWh/m^2/day or more
2. Terrain slope is ≤5%
3. Site is within 25 miles of transmission lines at 69-345 kV
4. The minimum parcel size of 40 continuous acres is available
5. Site is within 25 miles of graded roads or rail
6. Inventoried Roadless Areas and other Specially Designated areas are excluded

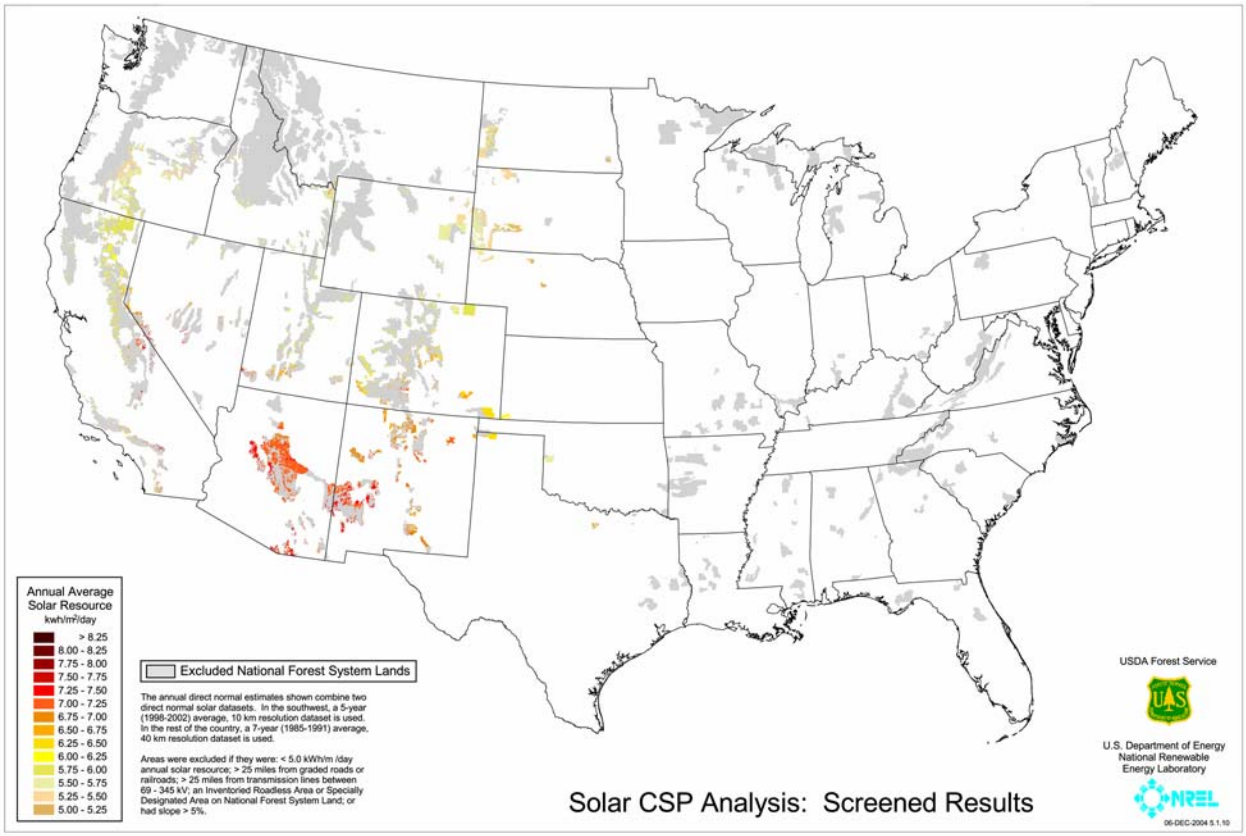


Figure 1. Solar CSP Analysis: Screened Results

PV

1. PV solar resource is 5 kWh/m^2/day or more
2. Terrain slope is ≤5%
3. Site is within 25 miles of transmission lines at 69-345 kV
4. The minimum parcel size of 40 continuous acres is available
5. Site is within 25 miles of graded roads or rail
6. Inventoried Roadless Areas and other Specially Designated Areas are excluded

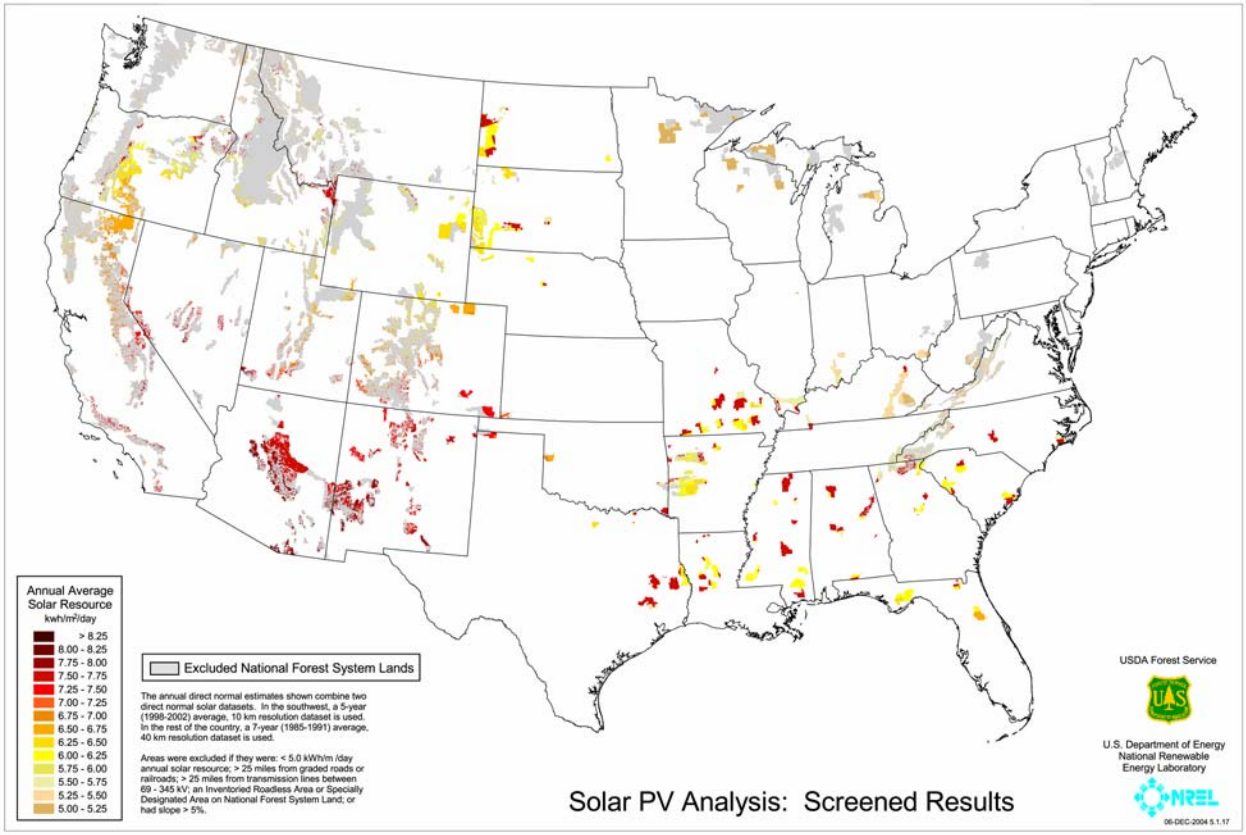


Figure 2. Solar PV Analysis: Screened Results

Wind

1. Wind resource is Wind Power Class 3 or more
2. Site is within 25 miles of transmission lines at 69-345 kV
3. Site is within 25 miles of a major road
4. Inventoried Roadless Areas and other Specially Designated Areas are excluded
5. Site is not within 3 km of an urban area
6. Slope of land is 20% or less

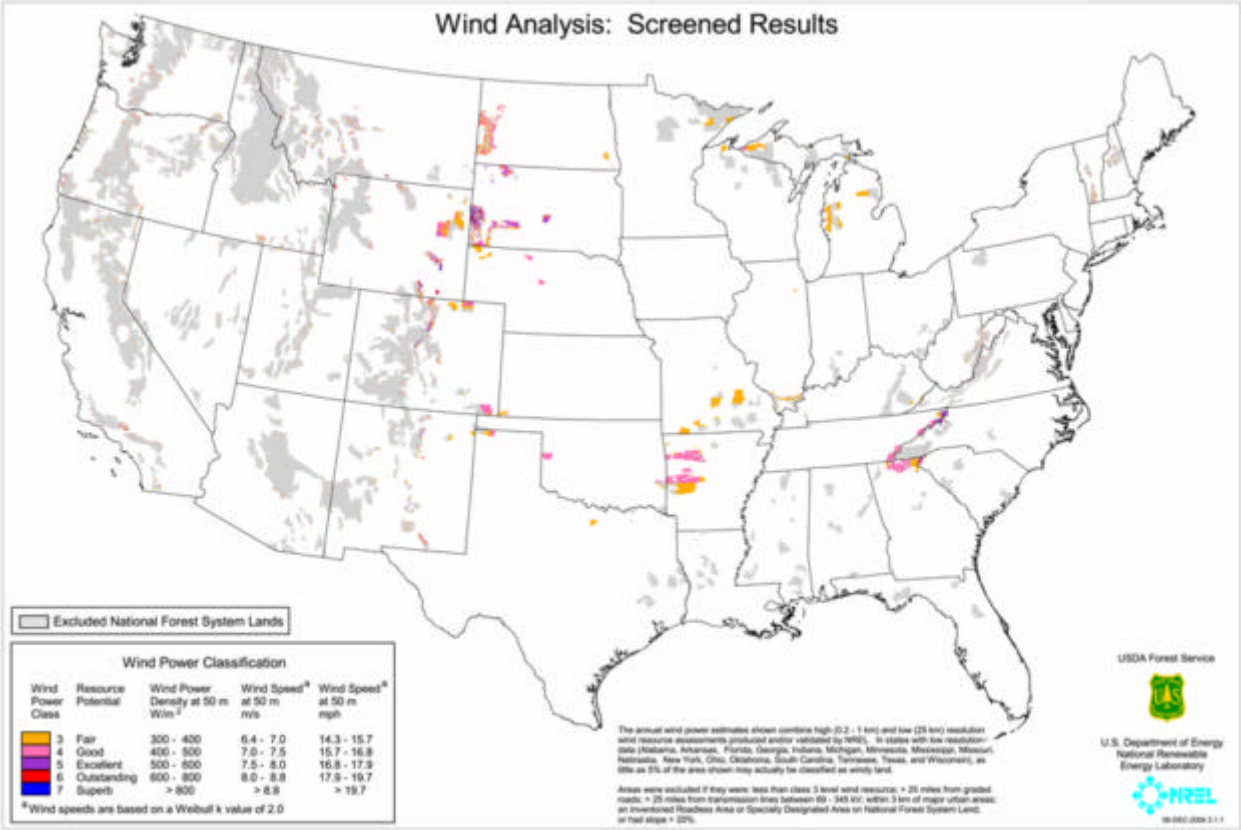


Figure 3. Wind Analysis: Screened Results

Each screening criterion was developed into a separate data layer indicating whether the criterion was met. The layers were combined into a final data set that included only lands that met all the criteria for each technology. Maps of individual criteria are in Appendix A.

The criteria listed above were used to identify areas with long-term development potential. A more restrictive definition of resource availability was used in identifying the NFS Units with the highest near-term development potential. These NFS Units should not be considered the only areas with significant development potential, however.

Task 4. Documenting High-Potential Areas for Inclusion in a Solar and Wind Energy Action Plan

This report is the product of this task. To develop recommendations for this report, USFS and NREL performed a comparative analysis. They used the solar and wind energy GIS maps resulting from Task 3 to conduct the analysis.

5. The Comparative Analysis

The GIS maps constructed for Task 3 were used as a starting point to identify the NFS Units with sites having the highest potential for solar and wind energy development. NREL technology experts developed the following final technology-specific decision rules. Each rule was used as a last screening criterion to eliminate marginal and less desirable solar and wind energy sites from the final maps developed under Task 3.

CSP

Include all sites with a solar resource of 7 kWh/m^2/day or greater and terrain slope less than or equal to 1%.

PV

Include all sites with a solar resource of 7 kWh/m^2/day or more and terrain slope less than or equal to 1%.

Wind

Include all sites that are in Wind Class 4 or greater and are within the proximity of either a major load center (city) or a major transmission line connecting with a major load center.

After the final decision rules were applied to technology-specific maps, the land area of the remaining solar and wind energy sites was summed on an administrative forest unit basis. This summed list was then rank-ordered on a technology-by-technology basis. The top 25 NFS Units in the rank-ordered list were identified by the USFS/NREL team as units having the highest potential. NFS Units for each technology are presented in descending order of total land area for CSP, PV, and wind in Tables 1a-1c. Figure 4 presents a GIS map representing the NFS Units with the highest potential for all technologies. From GIS screening analysis, estimates of maximum developable acres and related MW are also provided.

Table 1a. National Forest Units with the Largest Total Land Area of High-Potential Concentrating Solar Power Sites with Solar Resources of 7 kWh/m^2/Day or More (in Descending Order of Total Land Area)

National Forest Unit	State	Area (acres)	Maximum Development Potential (MW)*
Coconino	Arizona	222,509	44,502
Apache-Sitgreaves	Arizona	180,086	36,017
Cibola	New Mexico	93,157	18,631
Kaibab	Arizona	78,944	15,789
Prescott	Arizona	75,583	15,117
Gila	New Mexico	74,585	14,917
Tonto	Arizona	51,456	10,291
Coronado	Arizona	15,666	3,133
Santa Fe	New Mexico	14,490	2,898
Inyo	California	12,474	2,495
	Nevada	1,236	247
Inyo Total		*13,709*	*2,742*
Dixie	Utah	6,523	1,305
Humboldt-Toiyabe	California	69	14
	Nevada	4,092	818
Humboldt-Toiyabe Total		*4,161*	*832*
San Bernardino	California	3,647	729
Rio Grande	Colorado	3,064	613
Carson	New Mexico	2,323	465
Lincoln	New Mexico	2,224	445
Cleveland	California	1,236	247
Sequoia	California	979	196
Pike-San Isabel	Colorado	247	49
Sierra	California	237	47

* Assuming 1 MW per 5 acres

Table 1b. National Forest Units with the Largest Total Land Area of High-Potential Photovoltaic Sites with Solar Resources of 7 kWh/m^2/Day or More (in Descending Order of Total Land Area)

National Forest Unit	State	Area (acres)	Maximum Development Potential (MW)*
Pike-San Isabel	Colorado	448,832	89,766
Pike-San Isabel	Kansas	107,815	21,563
Cibola	New Mexico	189,150	37,830
	Texas	203,195	40,639
Cibola Total		*392,345*	*78,469*
Coconino	Arizona	230,900	46,180
Apache-Sitgreaves	Arizona	184,208	36,842
Kaibab	Arizona	109,248	21,850
Gila	New Mexico	89,401	17,880
Prescott	Arizona	79,942	15,988
Inyo	California	67,854	13,571
	Nevada	1,483	297
Inyo Total		*69,336*	*13,867*
Humboldt-Toiyabe	California	2,372	474
	Nevada	61,686	12,337
Humboldt-Toiyabe Total		*64,058*	*12,812*
Tonto	Arizona	57,021	11,404
Dixie	Utah	38,063	7,613
Carson	Colorado	10	2
	New Mexico	37,589	7,518
Carson Total		*37,599*	*7,520*

Table 1b (continued). National Forest Units with the Largest Total Land Area of High-Potential Photovoltaic Sites with Solar Resources of 7 kWh/m^2/Day or More (in Descending Order of Total Land Area)

National Forest Unit	State	Area (acres)	Maximum Development Potential (MW)*
Santa Fe	New Mexico	34,979	6,996
San Juan	Colorado	24,413	4,883
Lincoln	New Mexico	24,038	4,808
Coronado	Arizona	17,337	3,467
Los Padres	California	11,040	2,208
Rio Grande	Colorado	10,042	2,008
Plumas	California	8,510	1,702
Tahoe	California	7,334	1,467
Sierra	California	7,116	1,423
Sequoia	California	5,347	1,069
San Bernardino	California	4,557	911
Cleveland	California	3,954	791
Fishlake	Utah	2,224	445

* Assuming 1 MW per 5 acres.

Table 1c. National Forest Units with the Largest Total Land Area in Wind Class 4 or More (in Descending Order of Total Land Area)

National Forest Unit	State	Area (acres)	Maximum Development Potential (MW)*
Dakota Prairie Grasslands	North Dakota	836,453	16,925
	South Dakota	292,804	5,925
Dakota Prairie Grasslands Total		*1,129,257*	*22,850*
Nebraska	Nebraska	72,108	1,459
	South Dakota	889,303	17,995
Nebraska Total		*961,411*	*19,454*
Medicine Bow-Routt	Colorado	15,696	318
	Wyoming	870,859	17,622
Medicine Bow-Routt Total		*886,555*	*17,939*
Pike-San Isabel	Colorado	418,202	8,462
	Kansas	13,042	264
Pike-San Isabel Total		*431,244*	*8,726*
Arapaho-Roosevelt	Colorado	407,464	8,245
Cibola	New Mexico	12,750	258
	Oklahoma	138,887	2,810
	Texas	88,252	1,786
Cibola Total		*239,889*	*4,854*
Lincoln	New Mexico	91,101	1,843
Angeles	California	71,560	1,448

Table 1c (continued). National Forest Units with the Largest Total Land Area in Wind Class 4 or More (in Descending Order of Total Land Area)

National Forest Unit	State	Area (acres)	Maximum Development Potential (MW)*
Monongahela	West Virginia	63,159	1,278
Ottawa	Michigan	57,175	1,157
Green Mountain and Finger Lakes	New York	259	5
	Vermont	53,344	1,079
Green Mountain and Finger Lakes Total		*53,603*	*1,085*
Gifford Pinchot	Washington	52,059	1,053
Lolo	Montana	49,548	1,003
Idaho Panhandle	Idaho	47,582	963
	Montana	1,690	34
	Washington	99	2
Idaho Panhandle Total		*49,371*	*999*
Mt. Hood	Oregon	47,621	964
Ouachita	Arkansas	40,086	811
	Oklahoma	2,828	57
Ouachita Total		*42,913*	*868*
Cherokee	Tennessee	42,321	856
Wenatchee	Washington	40,297	815

Table 1c (continued). National Forest Units with the Largest Total Land Area in Wind Class 4 or More (in Descending Order of Total Land Area)

National Forest Unit	State	Area (acres)	Maximum Development Potential (MW)*
White Mountain	Maine	1,522	31
	New Hampshire	36,185	732
White Mountain Total		*37,707*	*763*
Santa Fe	New Mexico	36,630	741
George Washington	Virginia	29,069	588
	West Virginia	6,741	136
George Washington Total		*35,810*	*725*
National Forests in North Carolina	North Carolina	34,707	702
Sawtooth	Idaho	27,873	564
	Utah	6,029	122
Sawtooth Total		*33,902*	*686*
Humboldt-Toiyabe	California	8,767	177
	Nevada	24,987	506
Humboldt-Toiyabe Total		*33,754*	*683*
Chattahoochee-Oconee	Georgia	33,075	669

* Installed nameplate capacity, assuming ~1 MW per 50 acres.

Consolidated Information for USFS Use

Table 2 lists all the NFS Units that appear on three or more of the technology-specific lists (Tables 1a-1c). The nine states having NFS Units with two or more solar and wind resources are Arizona, California, Colorado, Kansas, New Mexico, Nevada, Oklahoma, Texas, and Utah. USFS may want to consider the particularly high solar and wind energy resource potential when making land management decisions on those NFS Units that appear at the top of the table. However, two important points must be considered:

1. First, while the NFS Units listed in Tables 1a-c and Table 2 are intended to represent those having the highest potential solar and wind energy development, these tables are not an exhaustive list of NFS Units with attractive solar and wind energy sites. For example, many National Forest Units may have 100 MW potential of interest to industry and surrounding communities.

2. Second, some NFS Units may contain outstanding sites for one specific technology to the exclusion of others. If expected project economics are favorable enough, it may be advisable to give as much, or more, consideration to the potential for solar or wind energy development in the land and resource management decisions of these sites over those of others that contain favorable sites for multiple technologies. Thus, Table 2 must be viewed primarily as a starting point for discussions regarding the consideration of solar and wind energy potential in USFS land and resource management decisions.

Table 2. U.S. National Forest Units with High Potential for the Development of Two or More Solar and Wind Energy Sources

National Forest Unit	State	CSP	PV	Wind
Three or more sources				
Cibola	New Mexico Oklahoma Texas	•	•	•
Humboldt-Toiyabe	California Nevada	•	•	•
Lincoln	New Mexico	•	•	•
Pike-San Isabel	Colorado Kansas	•	•	•
Sante Fe	California Nevada	•	•	•
Two or more sources				
Apache-Sitgreaves	Arizona	•	•	
Carson	New Mexico	•	•	
Cleveland	California	•	•	
Coconino	Arizona	•	•	
Coronado	Arizona New Mexico	•	•	
Dixie	Utah	•	•	
Gila	New Mexico	•	•	
Inyo	New Mexico	•	•	
Kaibab	Arizona	•	•	
Prescott	Arizona	•	•	
Rio Grande	Colorado	•	•	
San Bernardino	California	•	•	
Sequoia	California	•	•	
Sierra	California	•	•	
Tonto	Arizona	•	•	

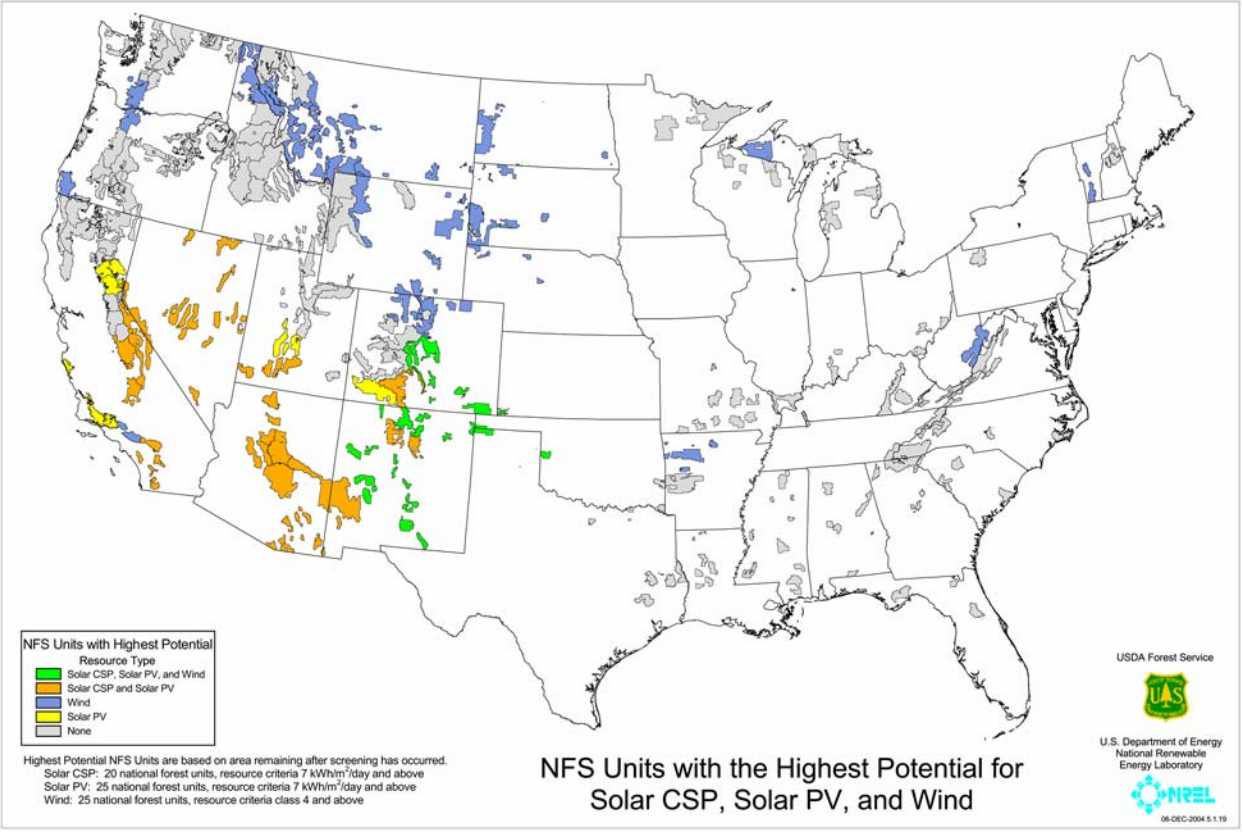


Figure 4. NFS Units with the Highest Potential for Solar CSP, Solar PV, and Wind

As an alternative way of viewing the assessment results, Appendix C, Tables C-1A, C-1B, and C-1C list all NFS Units, with some level of screened resource, in alphabetical order providing Maximum Development Potential (in MW) for CSP, PV, and Wind. Appendix C, Table C-2 lists all NFS Units, with some level of screened resource, providing Maximum Development Potential (in MW) and grouped by state. State Renewable Energy Climate ratings from Table 3 are supported with detailed Federal and State solar and wind energy policies listed in Table D-1 as of November 2004.

State Government Solar and Wind Energy Policies

State-level policies are also an important consideration in land management decisions. As a result of an ongoing deregulating process, many states have enacted a variety of laws and rules providing incentives for solar and wind energy use. However, the size of these incentives varies from state to state. Some states have worked aggressively to create an environment in which solar and wind energy projects have the potential to flourish, while others have adopted a more policy-neutral response. Because the energy policy environment in each state will evolve over time, current state-level incentives should not be the primary driver of USFS land use decisions with respect to solar and wind energy. Current state-level incentives should rather serve as just another piece of information in land and resource management decisions. Table 3 summarizes major state-specific solar and wind energy policies for the 24 states that were identified on the Top 25 NFS Units listed in Tables 1a-c.

Table 3. Summary of State Solar and Wind Energy Policies

State	Solar and Wind Energy Climate	Key Policies
Arizona	Highly Favorable	Many policies are in place, including (1) a green-tag purchase program, (2) green-power purchasing, (3) generation disclosure, (4) net metering, and most important, (5) a solar and wind energy portfolio standard.
California	Highly Favorable	Many policies are in place, including (1) a solar and wind energy tax credit, (2) a supplemental energy payments production incentive, (3) a solar property tax exemption, (4) green-power purchasing, (5) generation disclosure, (6) a net-metering law, (7) a public benefits fund, and (8) a solar and wind energy portfolio standard.
Colorado	Highly Favorable	Colorado offers (1) a green-tag purchase program, (2) generation disclosure, (3) green-power purchasing, (4) net metering, and (5) a solar and wind energy portfolio standard.
Georgia	Favorable	Georgia has policies in place, including (1) a green-tag purchase program, (2) TVA – Green Power Switch Generation Partners Program, and (3) net metering.
Idaho	Neutral	Idaho Power offers a green-tag purchase program, and net metering.
Kansas	Neutral	Kansas offers a green-tag purchase program and a solar and wind energy property tax exemption.
Maine	Highly Favorable	Many policies are in place, including (1) a green-tag purchase program, (2) generation disclosure, (3) green-power purchasing, (4) net metering, and (5) a solar and wind portfolio standard.
Michigan	Neutral	Multiple policies are in place, including (1) a green-tag purchase program, (2) a state grant program, and (3) generation disclosure.

Table 3 (continued). Summary of State Solar and Wind Energy Policies

State	Solar and Wind Energy Climate	Key Policies
Nevada	Highly Favorable	Many policies are in place, including (1) a green-tag purchase program, (2) solar and wind energy credits, (3) a renewable energy producers property tax exemption, (4) a renewable energy systems exemption, (5) a renewable energy/solar sales tax exemption, (6) generation disclosure, (7) a net-metering law, and most important, (8) a solar and wind energy portfolio standard.
New Hampshire	Neutral	New Hampshire offers a green-tag purchase program, and net metering.
New Mexico	Highly Favorable	Many policies are in place, including (1) a solar and wind energy production tax credit, (2) a green-tag purchase program, (3) a mandatory utility green-power option, (4) net metering, and (5) a solar and wind portfolio standard.
New York	Highly Favorable	New York offers (1) a green-tag purchase program, (2) a solar and wind energy systems exemption, (3) generation disclosure, (4) green-power purchasing, (5) net metering, (6) a systems benefit charge, and (7) a solar and wind portfolio standard.
North Carolina	Favorable	Multiple policies are in place, including (1) a green-tag purchase program, (2) TVA – Green Power Switch Generation Partners program, and (3) an energy improvement loan program.
North Dakota	Favorable	North Dakota offers (1) a green-tag purchase program; (2) a large wind property tax reduction; (3) a geothermal, solar, and wind property tax exemption; (4) a large wind sales tax exemption; and (5) net metering.
Oklahoma	Favorable	Many policies are in place, including (1) a zero emission facilities production tax credit, (2) a green-tag purchase program, and (3) net metering.

Table 3 (continued). Summary of State Solar and Wind Energy Policies

State	Solar and Wind Energy Climate	Key Policies
Oregon	Highly Favorable	Several policies in place, including (1) business energy tax credit, (2) a solar and wind energy grant, (3) Solar Starters production incentive, (4) a green-tag purchase program, (5) a new solar and wind energy resources grant, (6) a small-scale energy loan program, (7) green-power purchasing program, (8) generation disclosure, (9) net metering, and (10) a public benefits fund.
South Dakota	Neutral	South Dakota offers a green tag purchase program and a wind energy property tax exemption.
Tennessee	Favorable	Many policies are in place, including (1) a green-tag purchase program, (2) TVA – Green Power Switch Generation Partners program, and (3) a wind energy systems tax exemption.
Texas	Highly Favorable	Several policies are in place, including (1) a Hansford County tax abatement, (2) a green-tag purchase program, (3) generation disclosure, (4) net metering, and (5) a solar and wind energy portfolio standard.
Utah	Neutral	Utah offers (1) a green-tag purchase program, (2) green-power purchasing, and (3) net metering.
Vermont	Neutral	Multiple policies are in place, including (1) a green-tag purchase program, (2) biomass grants, (3) generation disclosure, and (4) net metering.
Washington	Favorable	Several policies are in place, including (1) a solar and wind energy grant, (2) Solar Starters production incentives, (3) a green-tag purchase program, (4) a sales and use tax exemption, (5) generation disclosure, (6) green- power purchasing, (7) a mandatory utility green-power option, and (8) net metering.
West Virginia	Favorable	West Virginia offers (1) a tax exemption for wind energy generation, (2) a green-tag purchase program, and (3) a special property tax assessment for wind energy systems.
Wyoming	Neutral	Wyoming has a green-tag purchase program and net metering.

6. Recommendations

1. Table 2 shows the NFS Units with the highest potential for projects using two or more solar and wind energy sources. The USFS can use Table 2 in decisions to revise or amend land use plans, in demonstrating the contribution that NFS lands can make toward the renewable energy component of the National Energy Policy.

2. As USFS addresses land management decisions and responds to proposals for solar or wind energy exploration and development on NFS Units, we recommend that USFS leverage some of the land management activities supporting solar and wind development currently being conducted on public lands managed by the Bureau of Land Management (BLM), including the following:

    a. BLM issued Instructional Memorandums for Interim Wind and Solar Development Policy providing guidance for BLM field offices to address and streamline industry applications for Right-of-Way (ROW) Grant Authorizations. The interim policy for wind may be accessed at http://www.blm.gov/nhp/efoia/wo/fy03/im2003-020.htm and the interim policy for solar development is available at http://www.blm.gov/nhp/efoia/wo/fy05/im2005-006.htm.

    b. BLM, in response to a high level of wind industry land use applications, is developing a Wind Programmatic Environmental Impact Statement (PEIS) for 11 western states. A BLM Record of Decision on the Final Wind PEIS is planned for summer of 2005. A key goal of the BLM Wind PEIS is to streamline land use plan amendments to incorporate wind power development. Additionally, the BLM Wind PEIS will provide best management practices for potential wind development projects, which may streamline industry National Environmental Policy Act compliance requirements for wind development on public lands. Because the PEIS is broad and not site specific, the USFS may consider adopting BLM Wind PEIS findings for land use planning decisions and potential industry applications for wind power projects.

    c. BLM has received more than 100 industry applications for wind resource monitoring and has processed more than 60 applications. USFS coordination with BLM on current land use permits for wind development may identify locations of land adjacent to USFS lands.

3. Consider participation with national and regional partnership organizations, focused on renewable energy development, such as State Wind Working Groups, National Wind Coordinating Council, Western Governors Association, and the Western Utility Group (focused on ROW corridor planning).

7. Appendices

A. U.S. Renewable Resource GIS Maps with High Potential Screening and Comparative Analysis Results

B. Detailed Description and Data Sets for GIS Maps

C. National Forest Units with Highest Solar and Wind Energy Potential

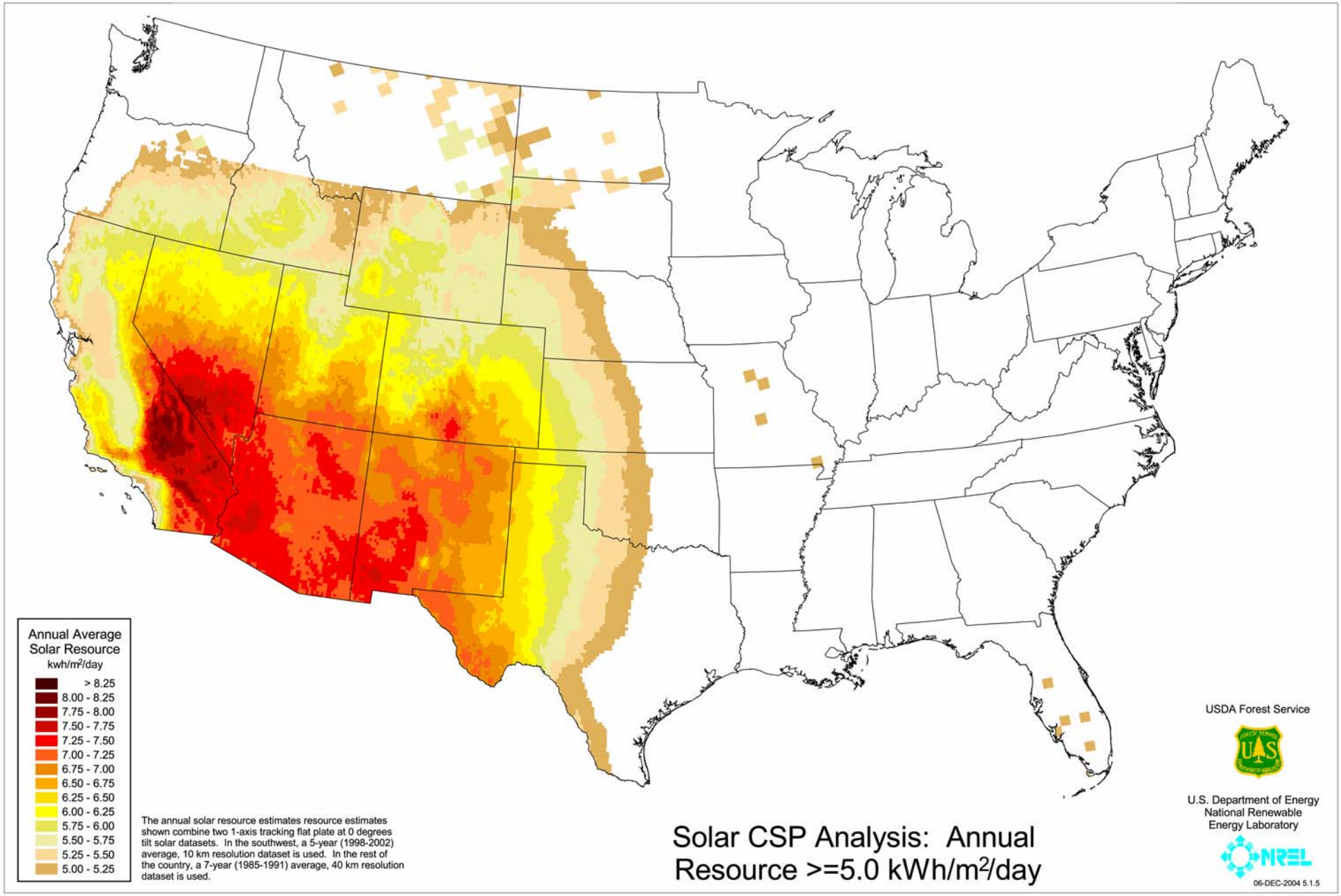
D. State Policies and Financial Incentives for Renewable Energy

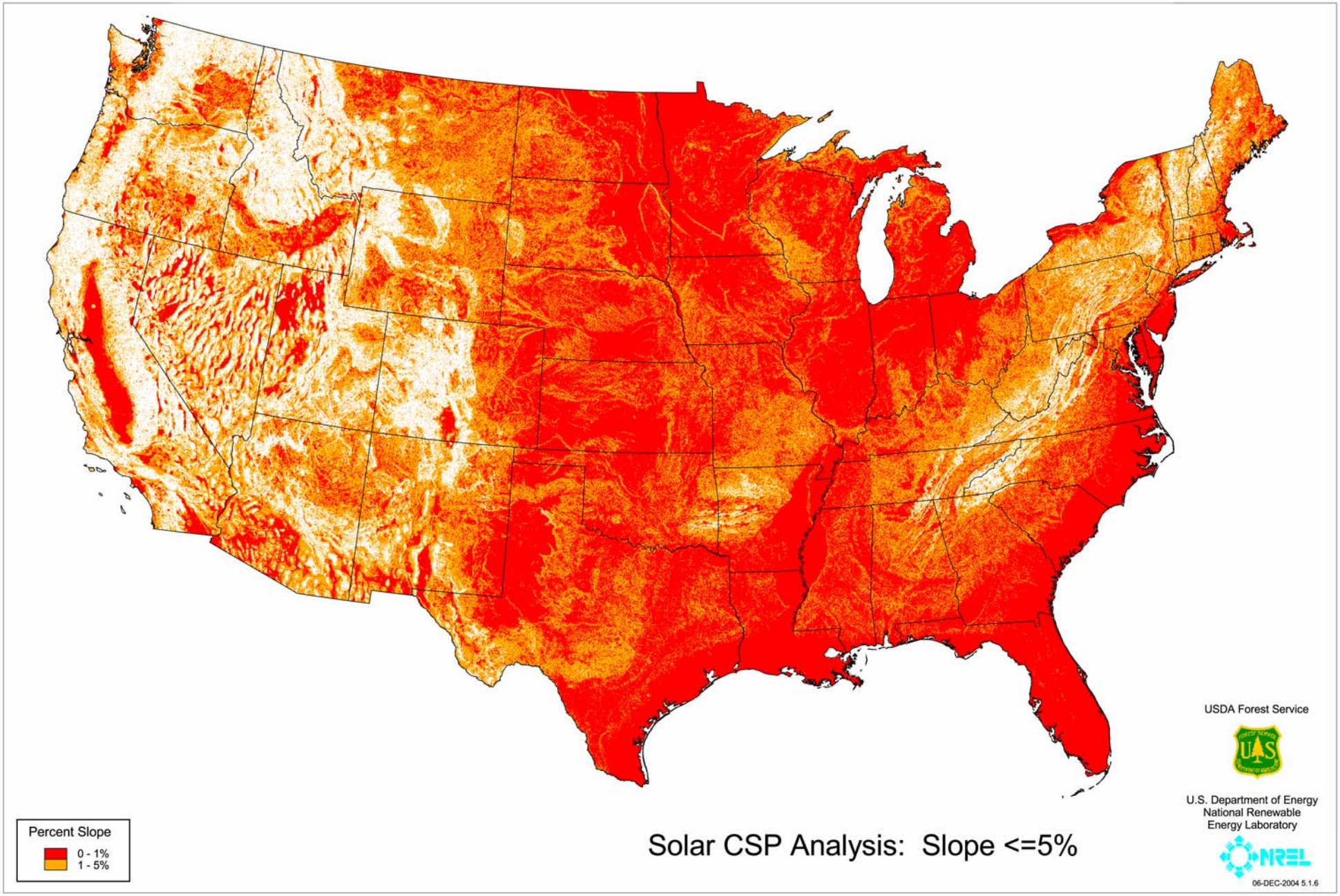
E. References

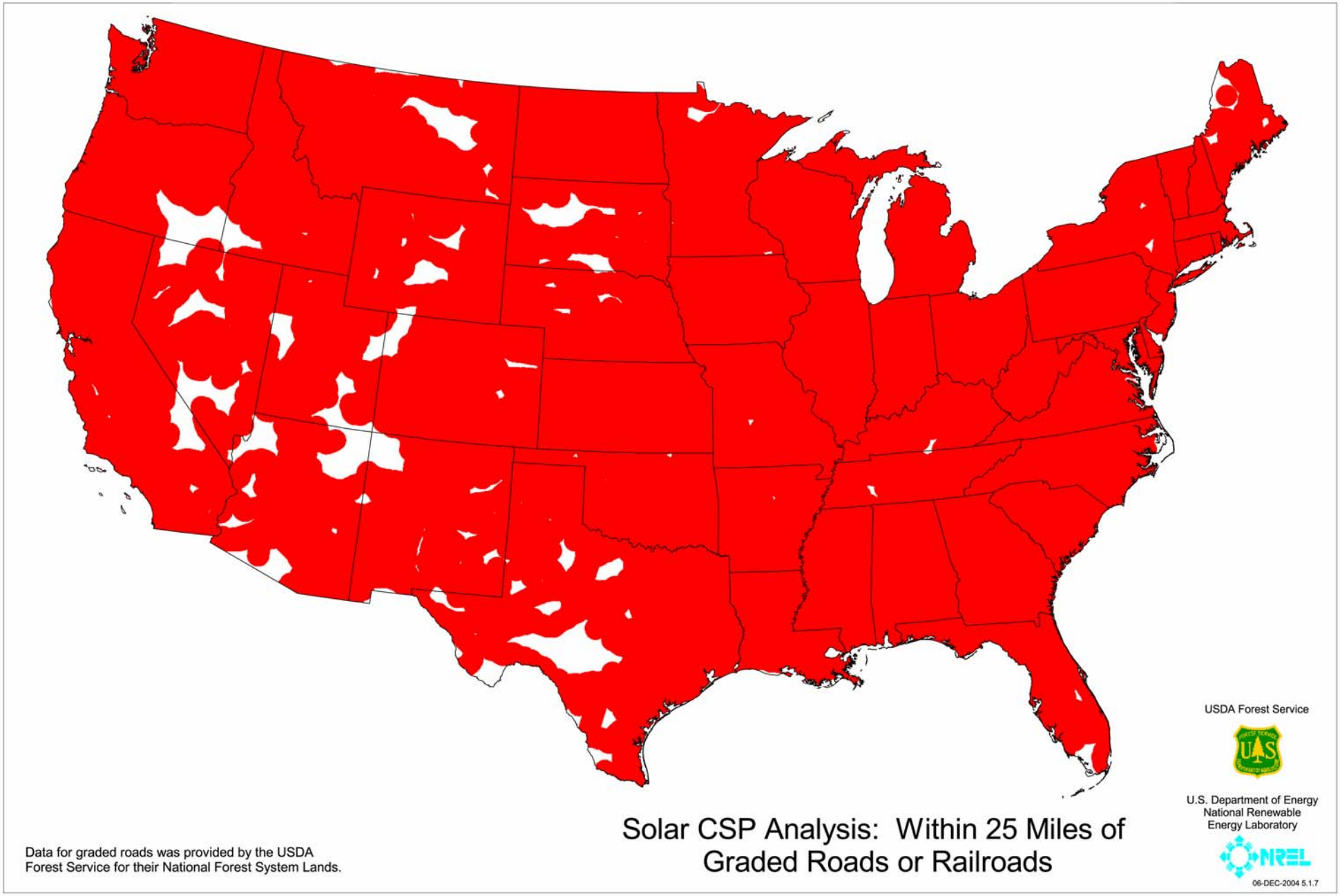
F. USFS, DOE, and NREL Contacts

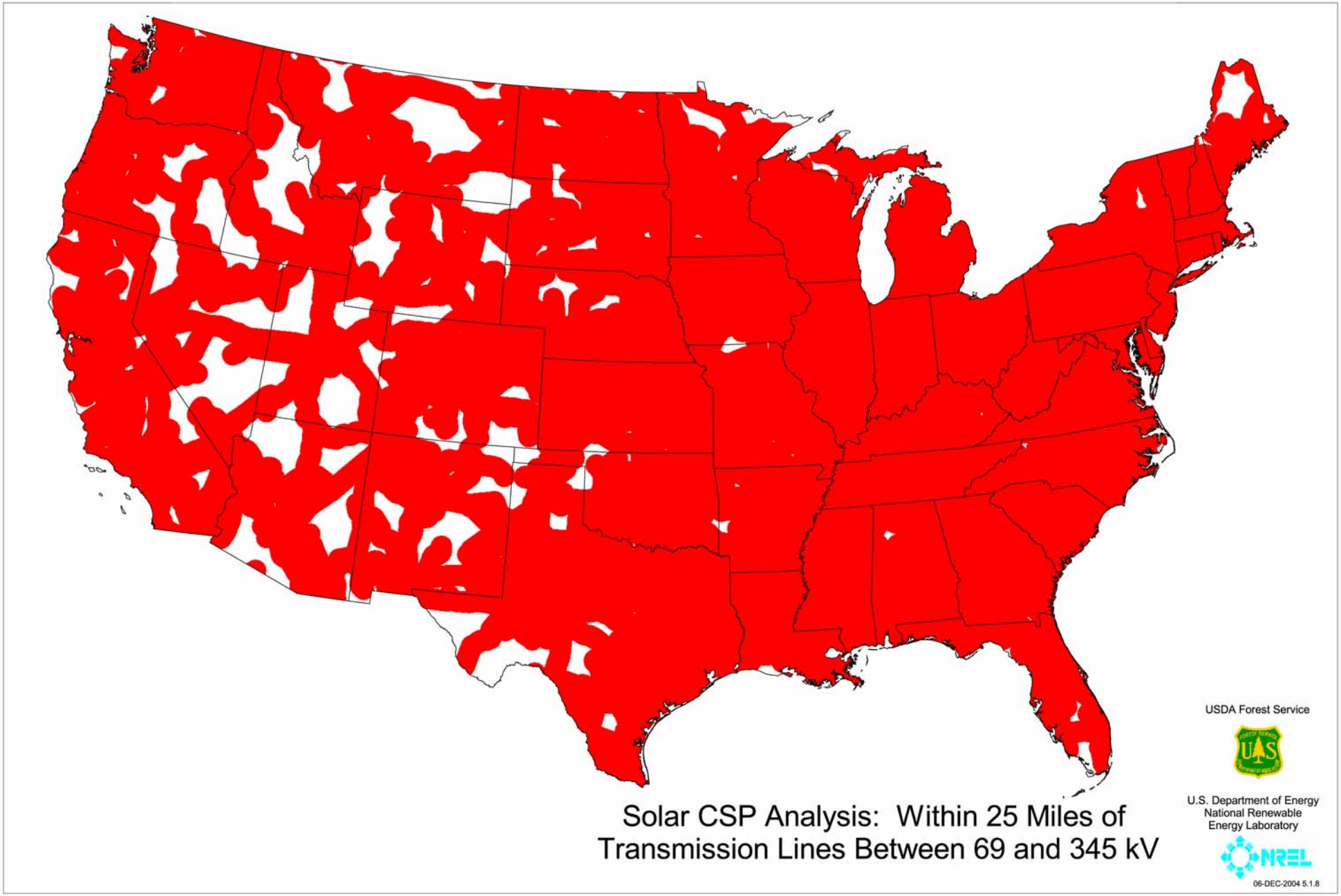
U.S. Renewable Resource GIS Maps with High Potential Screening and Comparative Analysis Results

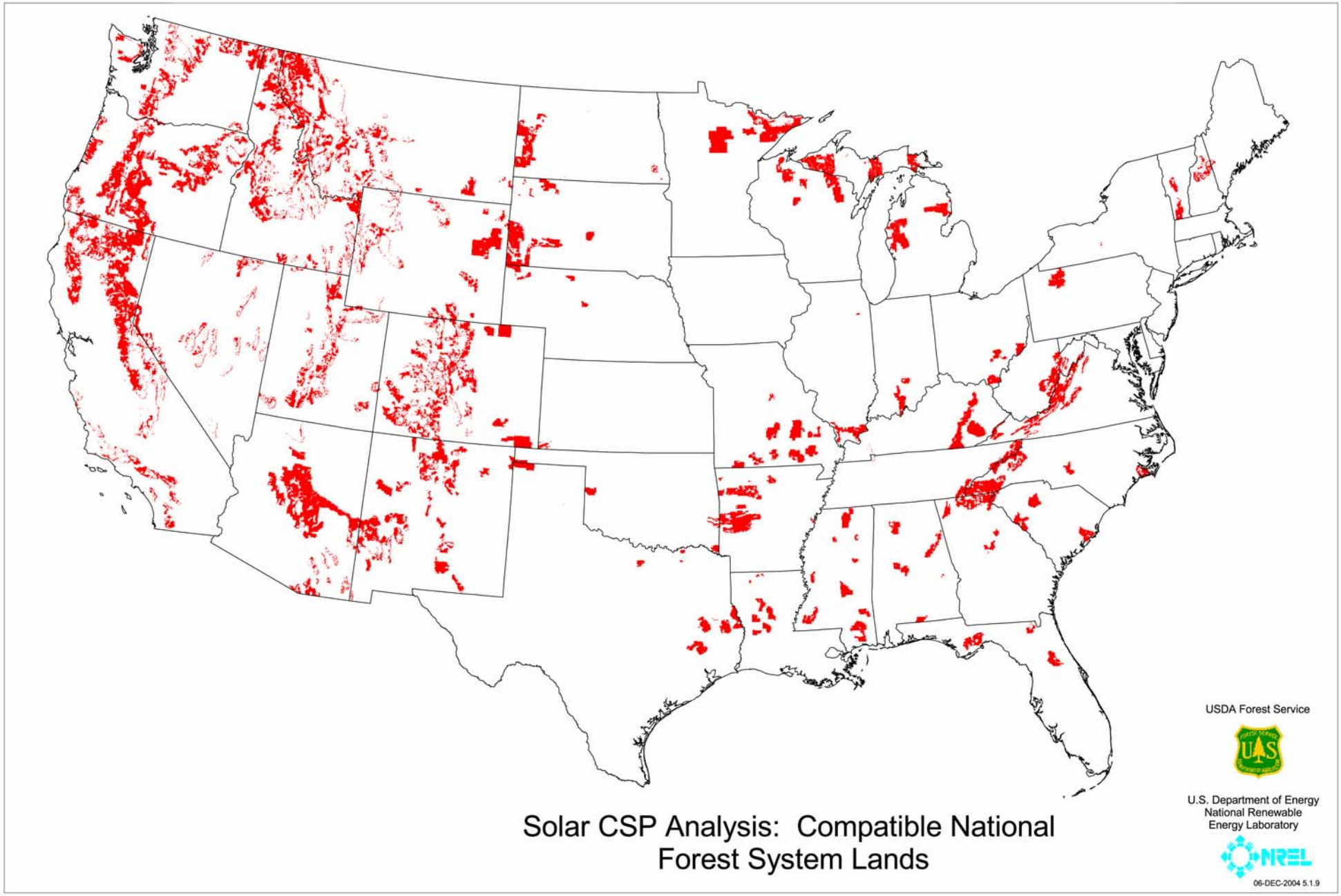
Solar CSP Analysis: Annual Resource >=.5.0 kWh/m^2/day	A – 2
Solar CSP Analysis: Slope <=5%	A – 3
Solar CSP Analysis: Within 25 Miles of Graded Roads or Railroads	A – 4
Solar CSP Analysis: Within 25 Miles of Transmission Lines Between 69 and 345 kV	A – 5
Solar CSP Analysis: Compatible National Forest System Lands	A – 6
Solar CSP Analysis: Screened Results	A – 7
Solar CSP Comparative Analysis: Results by National Forest Unit	A – 8
Solar PV Analysis: Annual Resource >=5.0 kWh/m^2/day	A – 9
Solar PV Analysis: Slope <=5%	A – 10
Solar PV Analysis: Within 25 Miles of Graded Roads or Railroads	A – 11
Solar PV Analysis: Within 25 Miles of Transmission Lines Between 69 and 345 kV	A – 12
Solar PV Analysis: Compatible National Forest System Lands	A – 13
Solar PV Analysis: Screened Results	A – 14
Solar PV Comparative Analysis: Results by National Forest Unit	A – 15
Wind Analysis: Annual Resource >=Class 3 at 50 m	A – 16
Wind Analysis: Within 25 Miles of Graded Roads on National Forest System Lands	A – 17
Wind Analysis: Within 25 Miles of Transmission Lines Between 69 and 345 kV	A – 18
Wind Analysis: Compatible National Forest System Lands	A – 19
Wind Analysis: Screened Results	A – 20
Wind Comparative Analysis: Results by National Forest Unit	A – 21
NFS Units with the Highest Potential for Solar CSP, Solar PV, and Wind	A – 22


Annual Average
Solar Resource
kwh/m2/day
> 8.25
8.00 - 8.25
7.75 - 8.00
7.50 - 7.75
7.25 - 7.50
7.00 - 7.25
6.75 - 7.00
6.50 - 6.75
6.25 - 6.50
6.00 - 6.25
5.75 - 6.00
5.50 - 5.75
5.25 - 5.50
5.00 - 5.25
The annual solar resource estimates resource estimates shown combine two 1-axis tracking flat plate at 0 degrees tilt solar datasets. In the southwest, a 5-year (1998-2002) average, 10 km resolution dataset is used. In the rest of the country, a 7-year (1985-1991) average, 40 km resolution dataset is used.
Solar CSP Analysis: Annual Resource >=5.0 kWh/m2/day
USDA Forest Service
U.S. Department of Energy
National Renewable
Energy Laboratory
NREL
06-DEC-2004 5.1.5


Percent Slope
0 - 1%
1 - 5%
Solar CSP Analysis: Slope <=5%
USDA Forest Service
U.S. Department of Energy
National Renewable
Energy Laboratory
NREL
06-DEC-2004 5.1.6


USDA Forest Service
U.S. Department of Energy
National Renewable
Energy Laboratory
NREL
06-DEC-2004 5.1.7
Solar CSP Analysis: Within 25 Miles of
Graded Roads or Railroads
Data for graded roads was provided by the USDA
Forest Service for their National Forest System Lands.


Solar CSP Analysis: Within 25 Miles of
Transmission Lines Between 69 and 345 kV
USDA Forest Service
U.S. Department of Energy
National Renewable
Energy Laboratory
NREL
06-DEC-2004 5.1.8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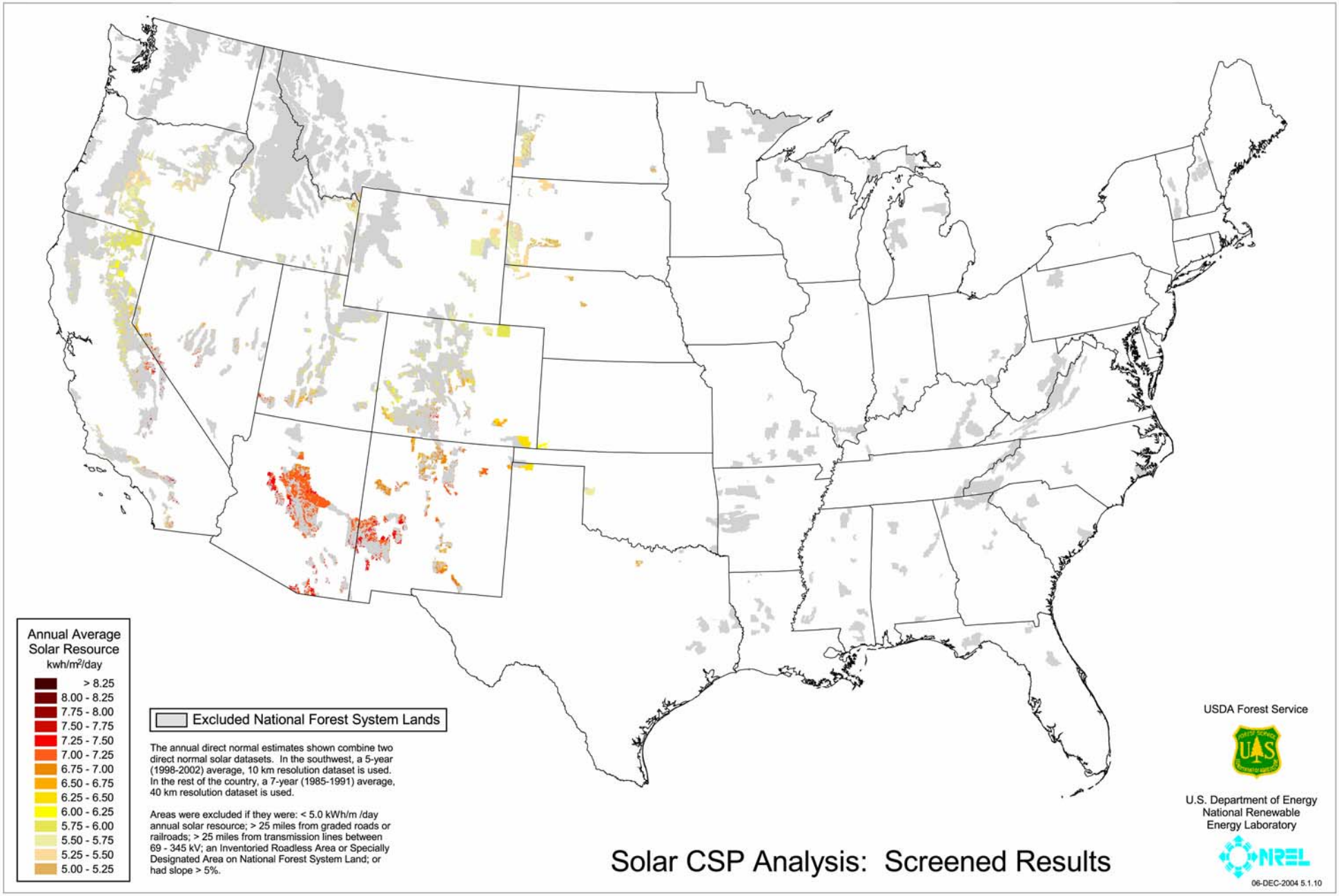
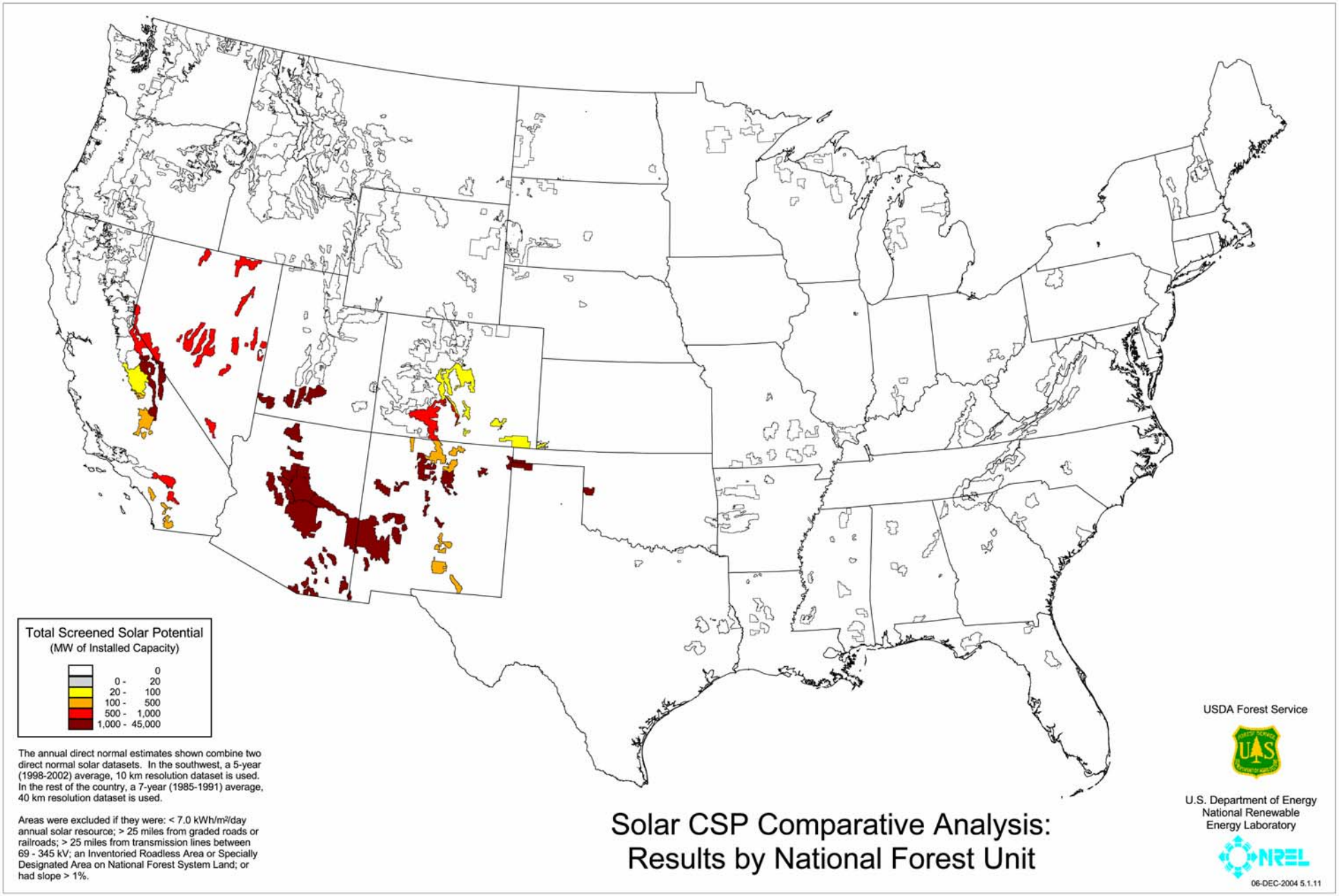
USDA Forest Service
U.S. Department of Energy
National Renewable
Energy Laboratory
NREL
06-DEC-2004 5.1.9


Annual Average
Solar Resource
kwh/m²/day
> 8.25
8.00 - 8.25
7.75 - 8.00
7.50 - 7.75
7.25 - 7.50
7.00 - 7.25
6.75 - 7.00
6.50 - 6.75
6.25 - 6.50
6.00 - 6.25
5.75 - 6.00
5.50 - 5.75
5.25 - 5.50
5.00 - 5.25
Excluded National Forest System Lands
The annual direct normal estimates shown combine two direct normal solar datasets. In the southwest, a 5-year (1998-2002) average, 10 km resolution dataset is used. In the rest of the country, a 7-year (1985-1991) average, 40 km resolution dataset is used.
Areas were excluded if they were: < 5.0 kWh/m /day annual solar resource; > 25 miles from graded roads or railroads; > 25 miles from transmission lines between 69 - 345 kV; an Inventoried Roadless Area or Specially Designated Area on National Forest System Land; or had slope > 5%.
Solar CSP Analysis: Screened Results
USDA Forest Service
U.S. Department of Energy
National Renewable
Energy Laboratory
NREL
06-DEC-2004 5.1.10


Total Screened Solar Potential
(MW of Installed Capacity)
0
0 - 20
20 - 100
100 - 500
500 - 1,000
1,000 - 45,000
The annual direct normal estimates shown combine two direct normal solar datasets. In the southwest, a 5-year (1998-2002) average, 10 km resolution dataset is used. In the rest of the country, a 7-year (1985-1991) average, 40 km resolution dataset is used.
Areas were excluded if they were: < 7.0 kWh/m²/day annual solar resource; > 25 miles from graded roads or railroads; > 25 miles from transmission lines between 69 - 345 kV; an Inventoried Roadless Area or Specially Designated Area on National Forest System Land; or had slope > 1%.
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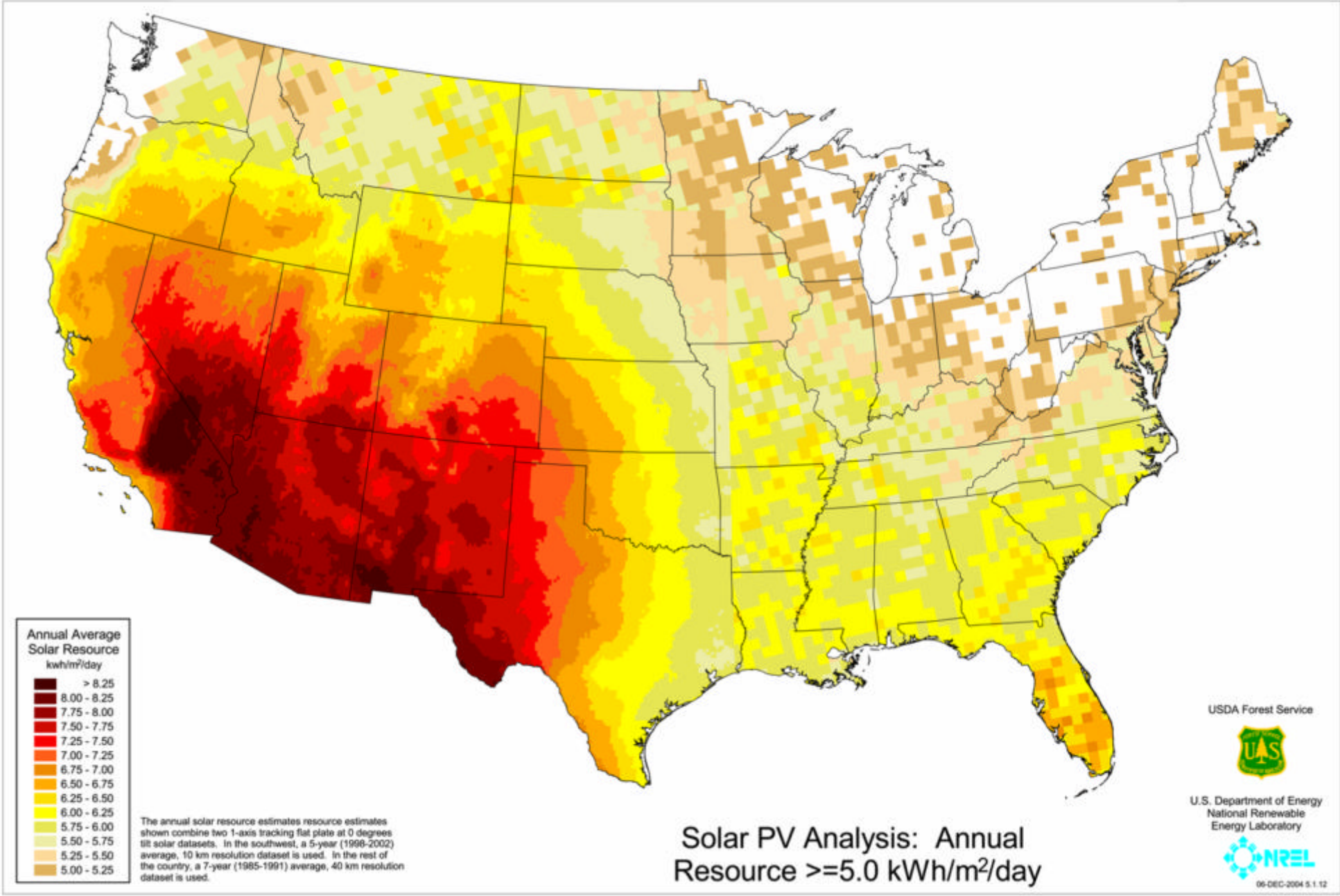
Results by National Forest Unit
USDA Forest Service
U.S. Department of Energy
National Renewable
Energy Laboratory
NREL
06-DEC-2004 5.1.11


Annual Average
Solar Resource
kwh/m²/day
> 8.25
8.00 - 8.25
7.75 - 8.00
7.50 - 7.75
7.25 - 7.50
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6.75 - 7.00
6.50 - 6.75
6.25 - 6.50
6.00 - 6.25
5.75 - 6.00
5.50 - 5.75
5.25 - 5.50
5.00 - 5.25
The annual solar resource estimates resource estimates shown combine two 1-axis tracking flat plate at 0 degrees tilt solar datasets. In the southwest, a 5-year (1998-2002) average, 10 km resolution dataset is used. In the rest of the country, a 7-year (1985-1991) average, 40 km resolution dataset is used.
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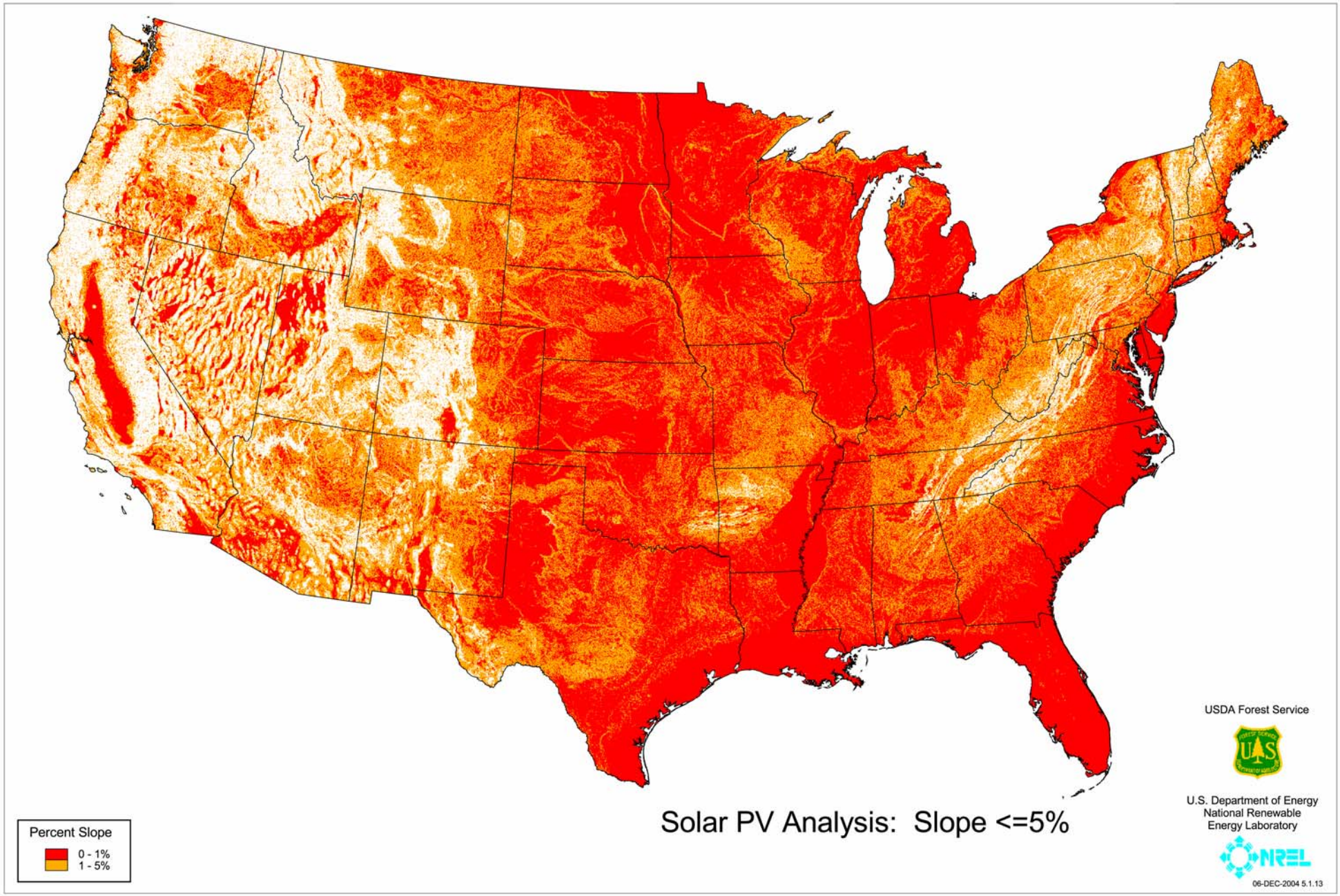
USDA Forest Service
U.S. Department of Energy
National Renewable
Energy Laboratory
NREL
06-DEC-2004 5.1.12


Solar PV Analysis: Slope <=5%
Percent Slope
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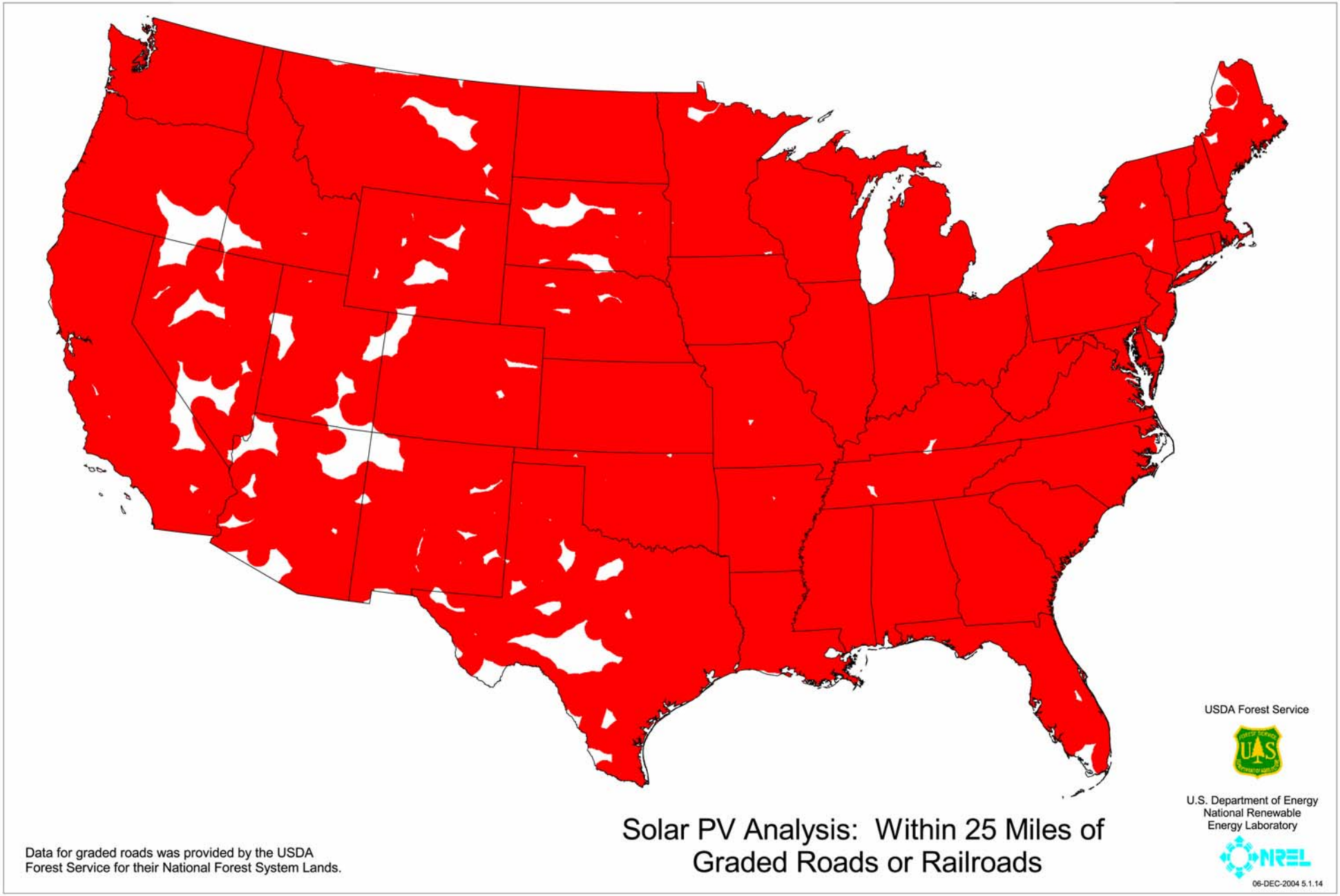
1 - 5%
USDA Forest Service
U.S. Department of Energy
National Renewable
Energy Laboratory
NREL
06-DEC-2004 5.1.13


Solar PV Analysis: Within 25 Miles of
Graded Roads or Railroads
Data for graded roads was provided by the USDA
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USDA Forest Service
U.S. Department of Energy
National Renewable
Energy Laboratory
NREL
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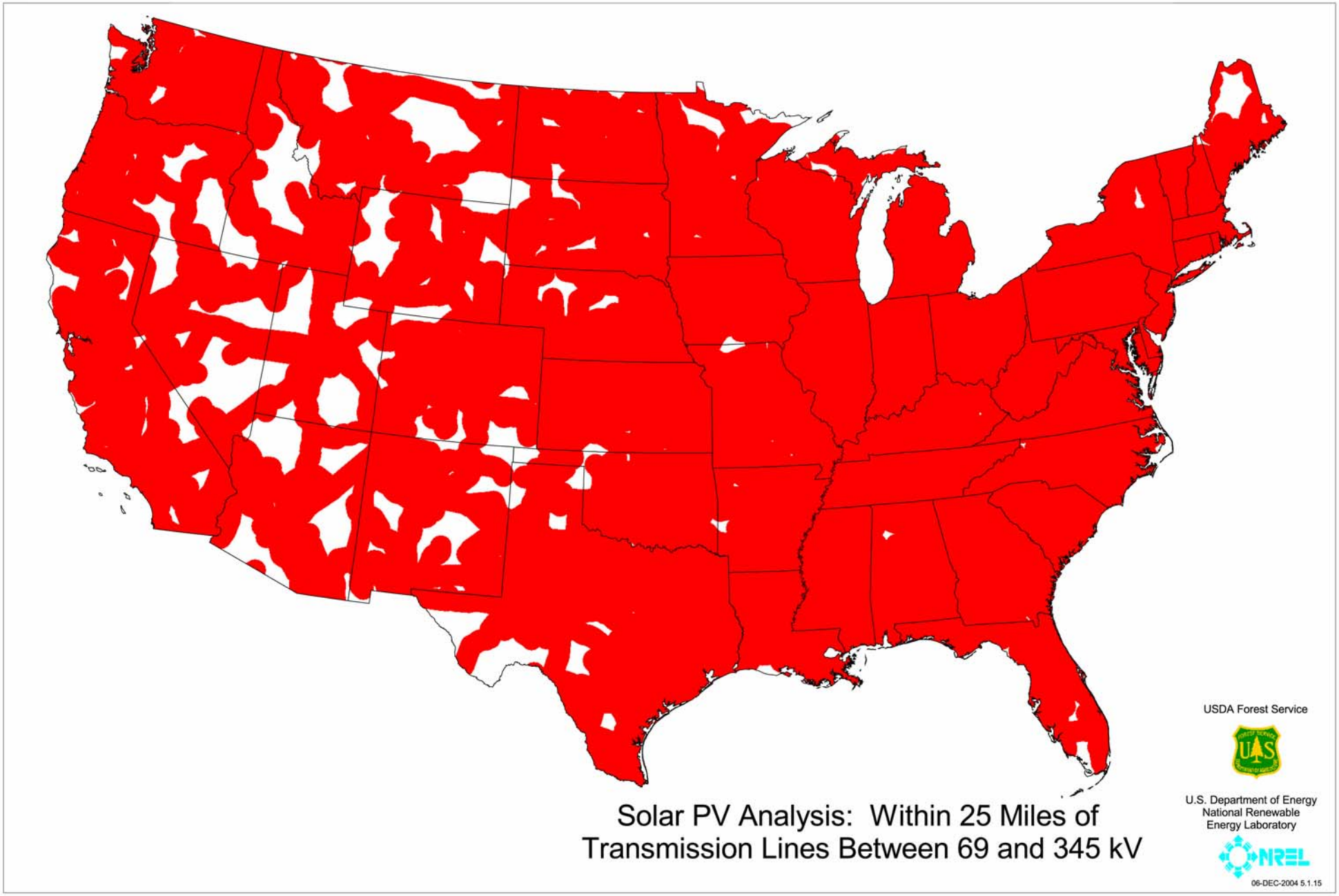
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U.S. Department of Energy
National Renewable
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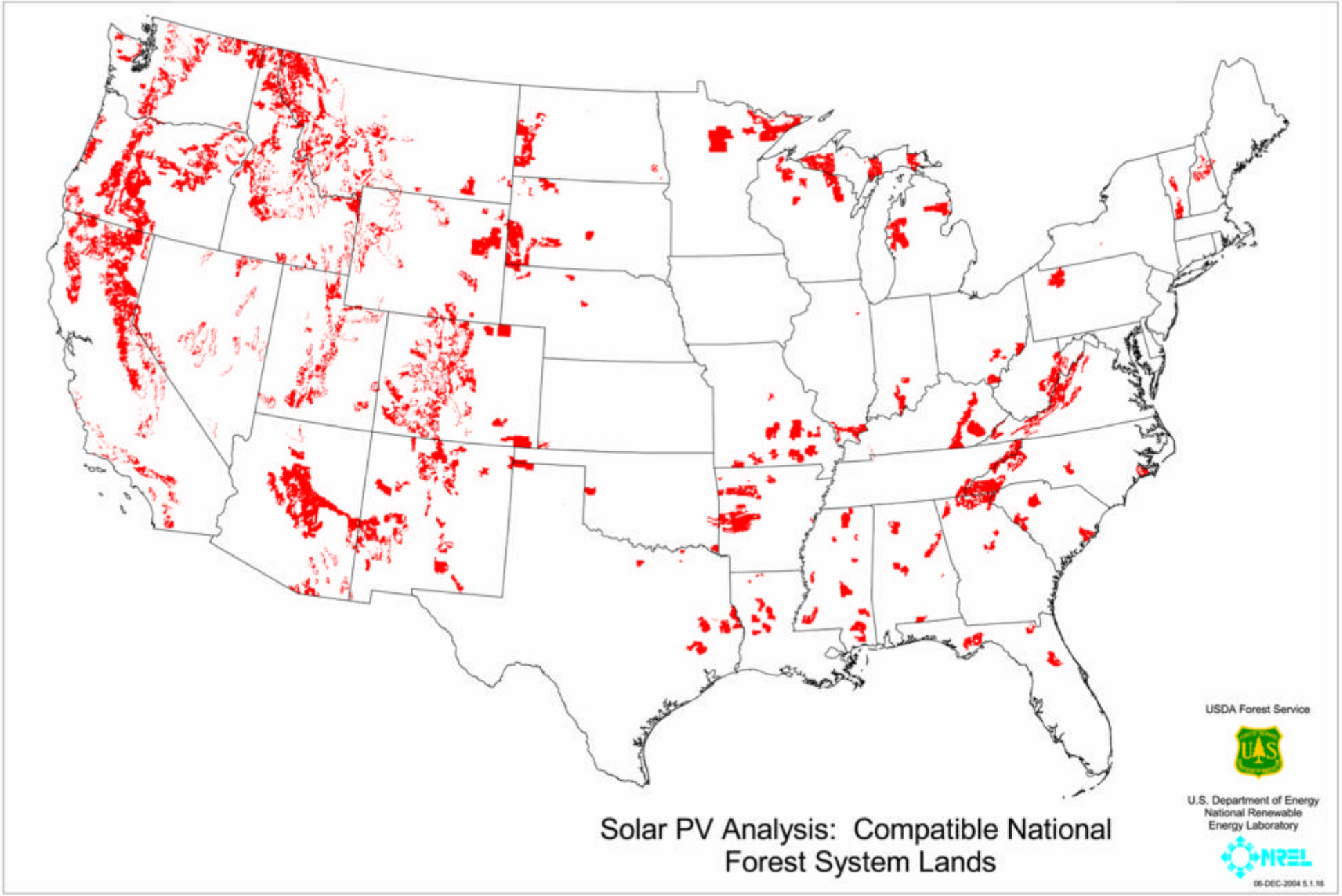
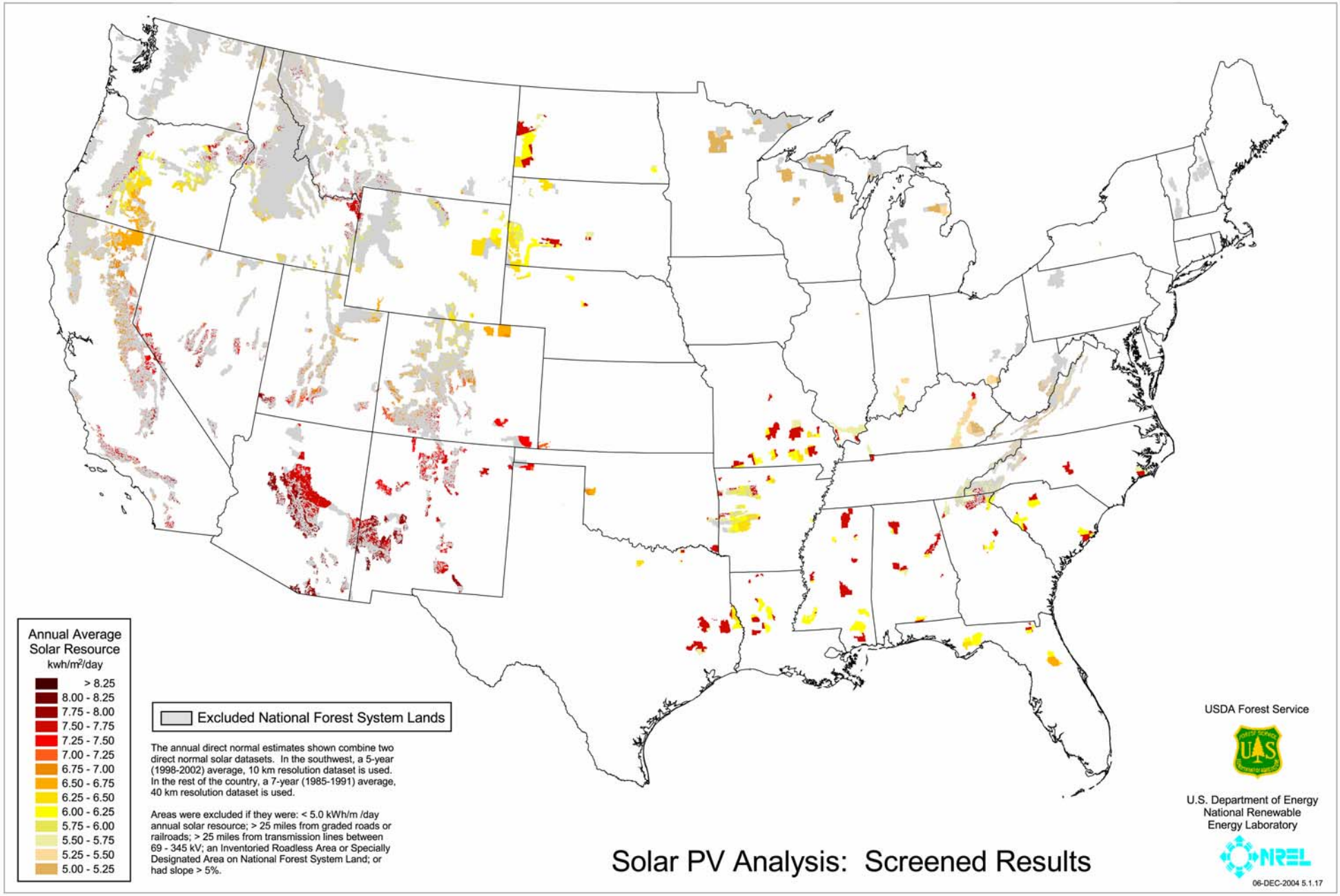
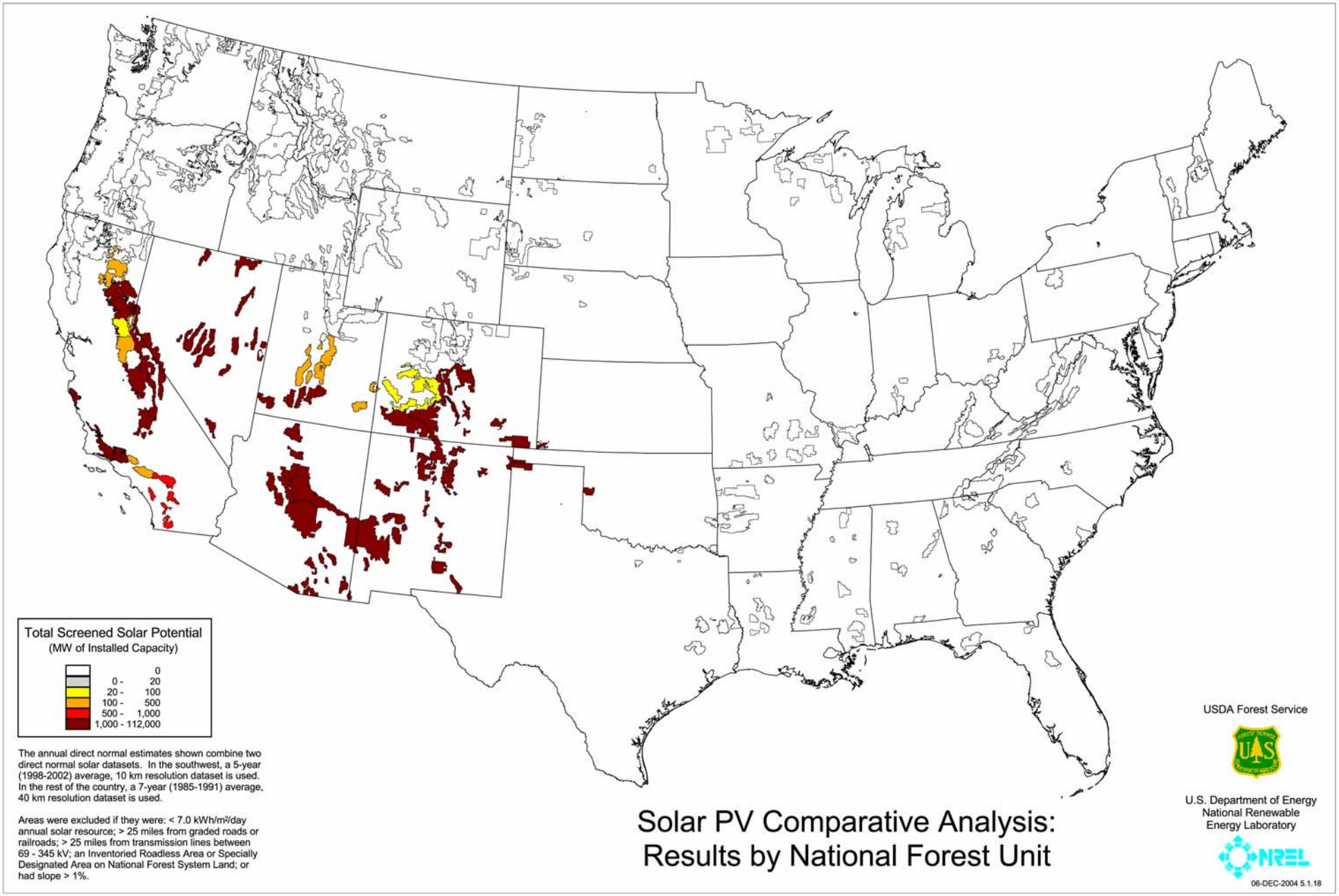
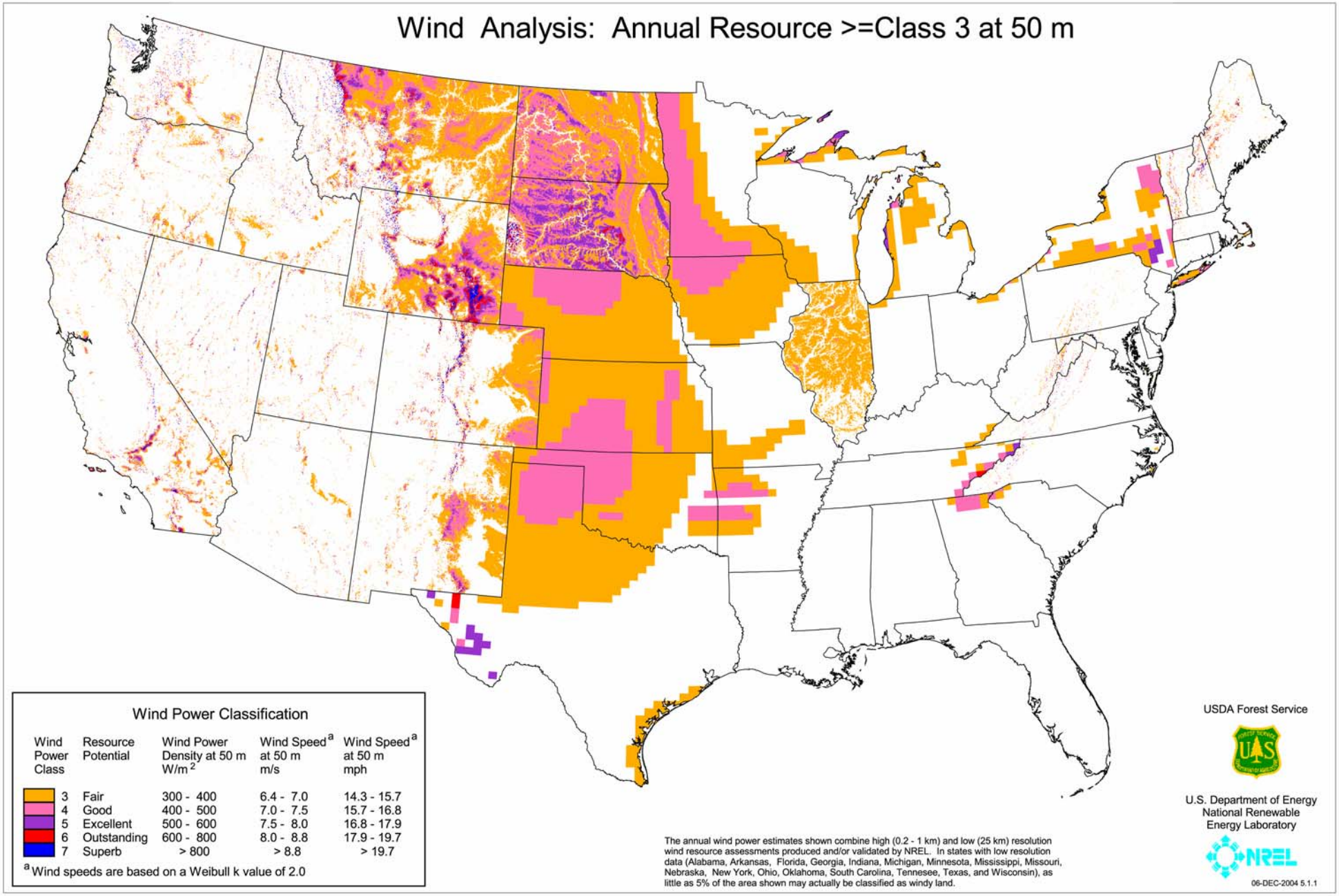
NREL
06-DEC-2004 5.1.15


Solar PV Analysis: Compatible National Forest System Lands
USDA Forest Service
U.S. Department of Energy
National Renewable
Energy Laboratory
NREL
06-DEC-2004 5.1.16


Annual Average
Solar Resource
kwh/m²/day
> 8.25
8.00 - 8.25
7.75 - 8.00
7.50 - 7.75
7.25 - 7.50
7.00 - 7.25
6.75 - 7.00
6.50 - 6.75
6.25 - 6.50
6.00 - 6.25
5.75 - 6.00
5.50 - 5.75
5.25 - 5.50
5.00 - 5.25
Excluded National Forest System Lands
The annual direct normal estimates shown combine two direct normal solar datasets. In the southwest, a 5-year (1998-2002) average, 10 km resolution dataset is used. In the rest of the country, a 7-year (1985-1991) average, 40 km resolution dataset is used.
Areas were excluded if they were: < 5.0 kWh/m /day annual solar resource; > 25 miles from graded roads or railroads; > 25 miles from transmission lines between 69 - 345 kV; an Inventoried Roadless Area or Specially Designated Area on National Forest System Land; or had slope > 5%.
Solar PV Analysis: Screened Results
USDA Forest Service
U.S. Department of Energy
National Renewable
Energy Laboratory
NREL
06-DEC-2004 5.1.17


Total Screened Solar Potential
(MW of Installed Capacity)
0
0 - 20
20 - 100
100 - 500
500 - 1,000
1,000 - 112,000
The annual direct normal estimates shown combine two direct normal solar datasets. In the southwest, a 5-year (1998-2002) average, 10 km resolution dataset is used. In the rest of the country, a 7-year (1985-1991) average, 40 km resolution dataset is used.
Areas were excluded if they were: < 7.0 kWh/m²/day annual solar resource; > 25 miles from graded roads or railroads; > 25 miles from transmission lines between 69 - 345 kV; an Inventoried Roadless Area or Specially Designated Area on National Forest System Land; or had slope > 1%.
Solar PV Comparative Analysis:
Results by National Forest Unit
USDA Forest Service
U.S. Department of Energy
National Renewable
Energy Laboratory
NREL
06-DEC-2004 5.1.18


Wind Analysis: Annual Resource >=Class 3 at 50 m
Wind Power Classification
Wind Power Class
Resource Potential
Wind Power Density at 50 m W/m 2
Wind Speed a at 50 m m/s
Wind Speed a at 50 m mph
3 Fair 300 - 400 6.4 - 7.0 14.3 - 15.7
4 Good 400 - 500 7.0 - 7.5 15.7 - 16.8
5 Excellent 500 - 600 7.5 - 8.0 16.8 - 17.9
6 Outstanding 600 - 800 8.0 - 8.8 17.9 - 19.7
7 Superb > 800 > 8.8 > 19.7
a Wind speeds are based on a Weibull k value of 2.0
The annual wind power estimates shown combine high (0.2 - 1 km) and low (25 km) resolution wind resource assessments produced and/or validated by NREL. In states with low resolution data (Alabama, Arkansas, Florida, Georgia, Indiana, Michigan, Minnesota, Mississippi, Missouri, Nebraska, New York, Ohio, Oklahoma, South Carolina, Tennesee, Texas, and Wisconsin), as little as 5% of the area shown may actually be classified as windy land.
USDA Forest Service
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Energy Laboratory
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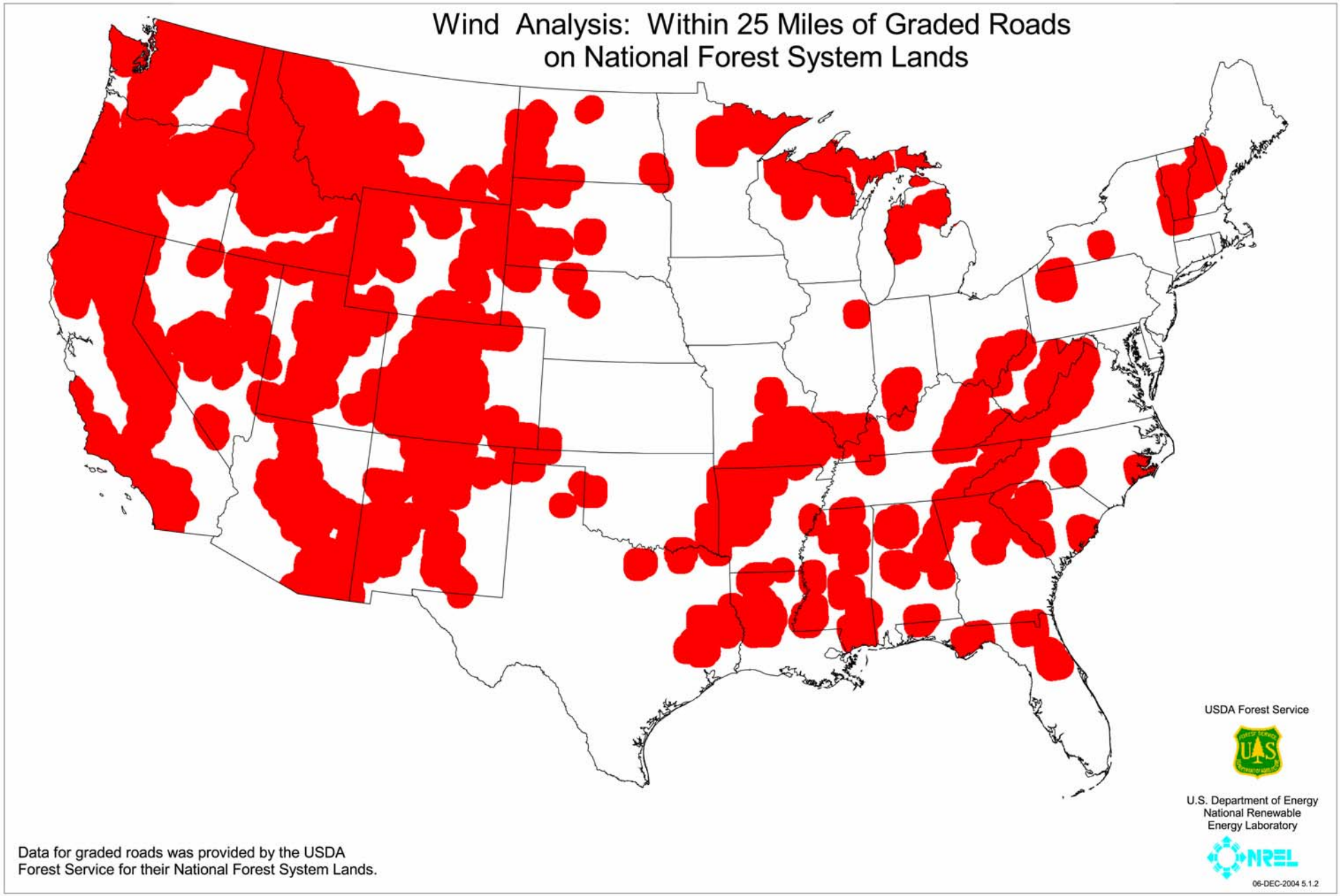
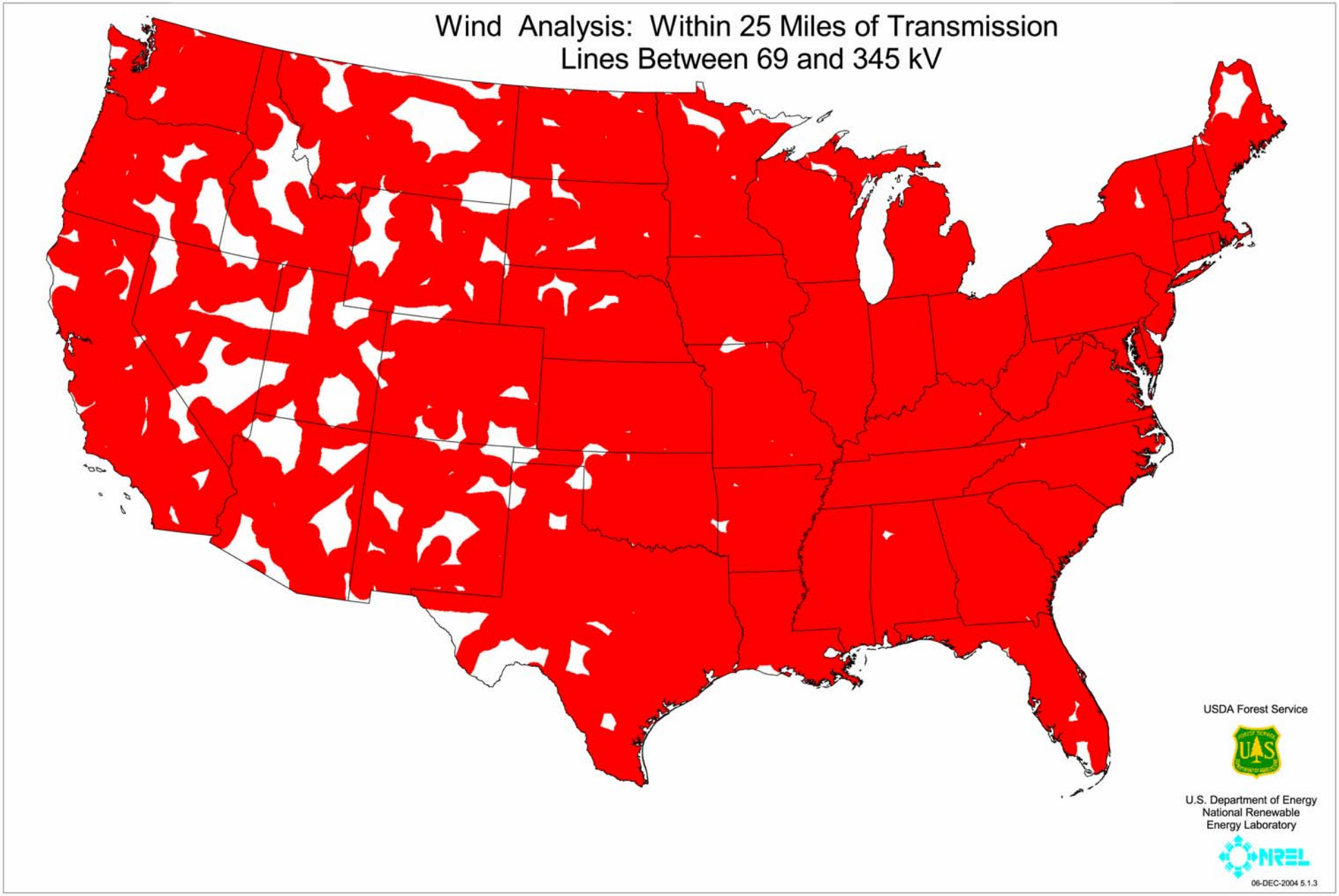
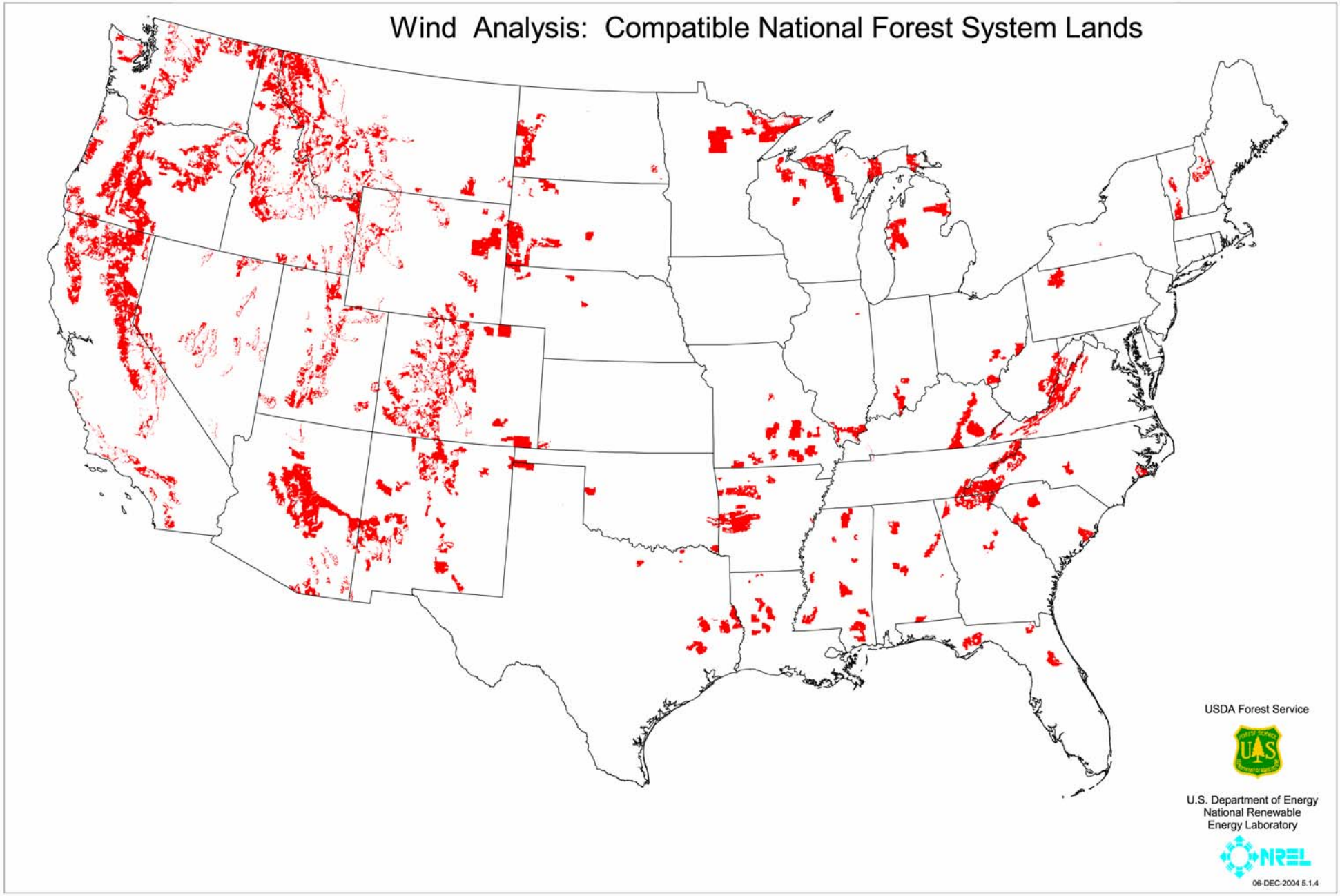
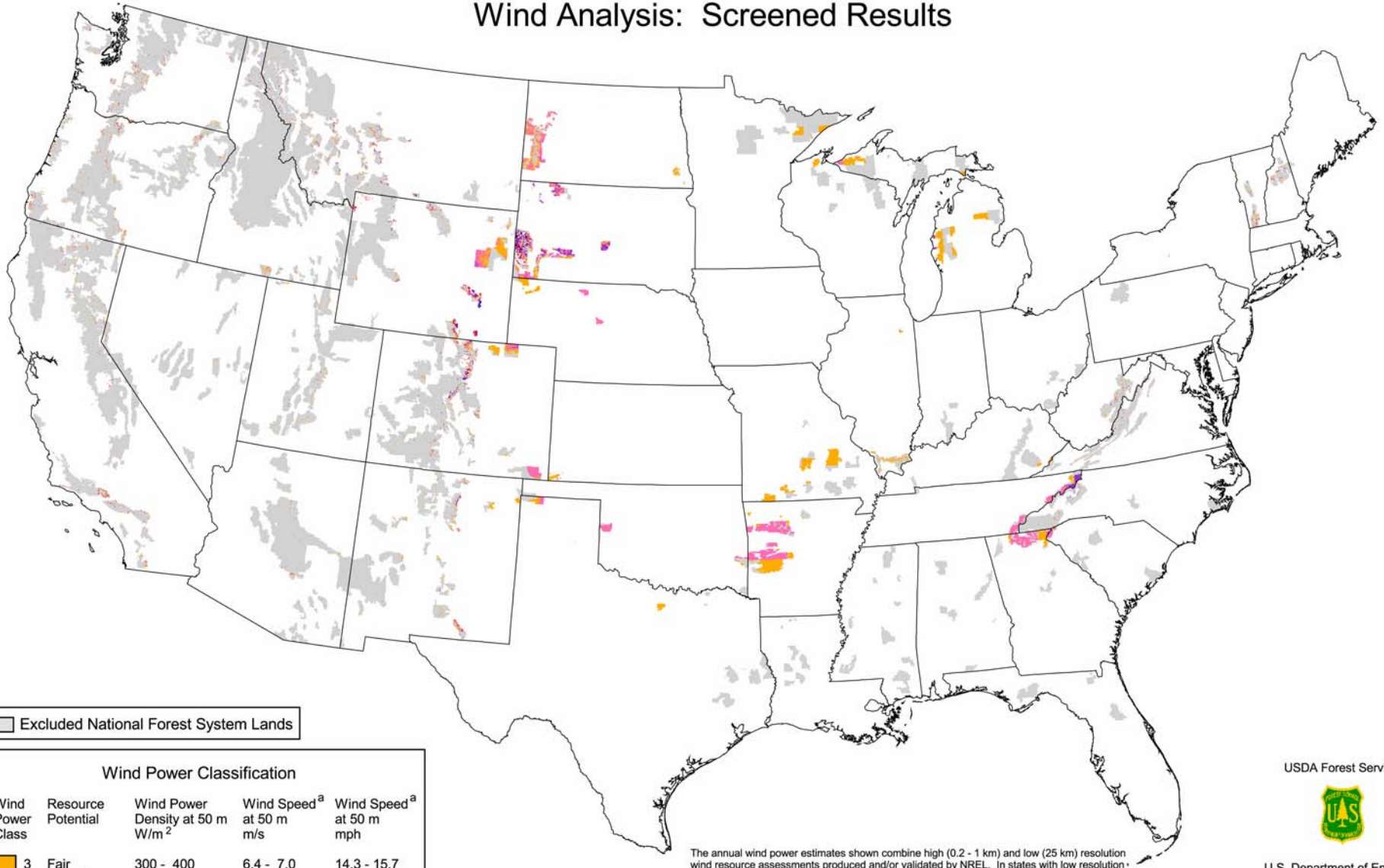

Wind Analysis: Within 25 Miles of Graded Roads
on National Forest System Lands
USDA Forest Service
U.S. Department of Energy
National Renewable
Energy Laboratory
NREL
06-DEC-2004 5.1.2
Data for graded roads was provided by the USDA
Forest Service for their National Forest System Lands.


Wind Analysis: Within 25 Miles of Transmission
Lines Between 69 and 345 kV
USDA Forest Service
U.S. Department of Energy
National Renewable
Energy Laboratory
NREL
06-DEC-2004 5.1.3


Wind Analysis: Compatible National Forest System Lands
USDA Forest Service
U.S. Department of Energy
National Renewable
Energy Laboratory
NREL
06-DEC-2004 5.1.4

Wind Analysis: Screened Results



Excluded National Forest System Lands

Wind Power Classification

Wind Power Class	Resource Potential	Wind Power Density at 50 m W/m^2	Wind Speed[a] at 50 m m/s	Wind Speed[a] at 50 m mph
3	Fair	300 - 400	6.4 - 7.0	14.3 - 15.7
4	Good	400 - 500	7.0 - 7.5	15.7 - 16.8
5	Excellent	500 - 600	7.5 - 8.0	16.8 - 17.9
6	Outstanding	600 - 800	8.0 - 8.8	17.9 - 19.7
7	Superb	> 800	> 8.8	> 19.7

[a] Wind speeds are based on a Weibull k value of 2.0

The annual wind power estimates shown combine high (0.2 - 1 km) and low (25 km) resolution wind resource assessments produced and/or validated by NREL. In states with low resolution data (Alabama, Arkansas, Florida, Georgia, Indiana, Michigan, Minnesota, Mississippi, Missouri, Nebraska, New York, Ohio, Oklahoma, South Carolina, Tennesee, Texas, and Wisconsin), as little as 5% of the area shown may actually be classified as windy land.

Areas were excluded if they were: less than class 3 level wind resource; > 25 miles from graded roads; > 25 miles from transmission lines between 69 - 345 kV; within 3 km of major urban areas; an Inventoried Roadless Area or Specially Designated Area on National Forest System Land; or had slope > 20%.

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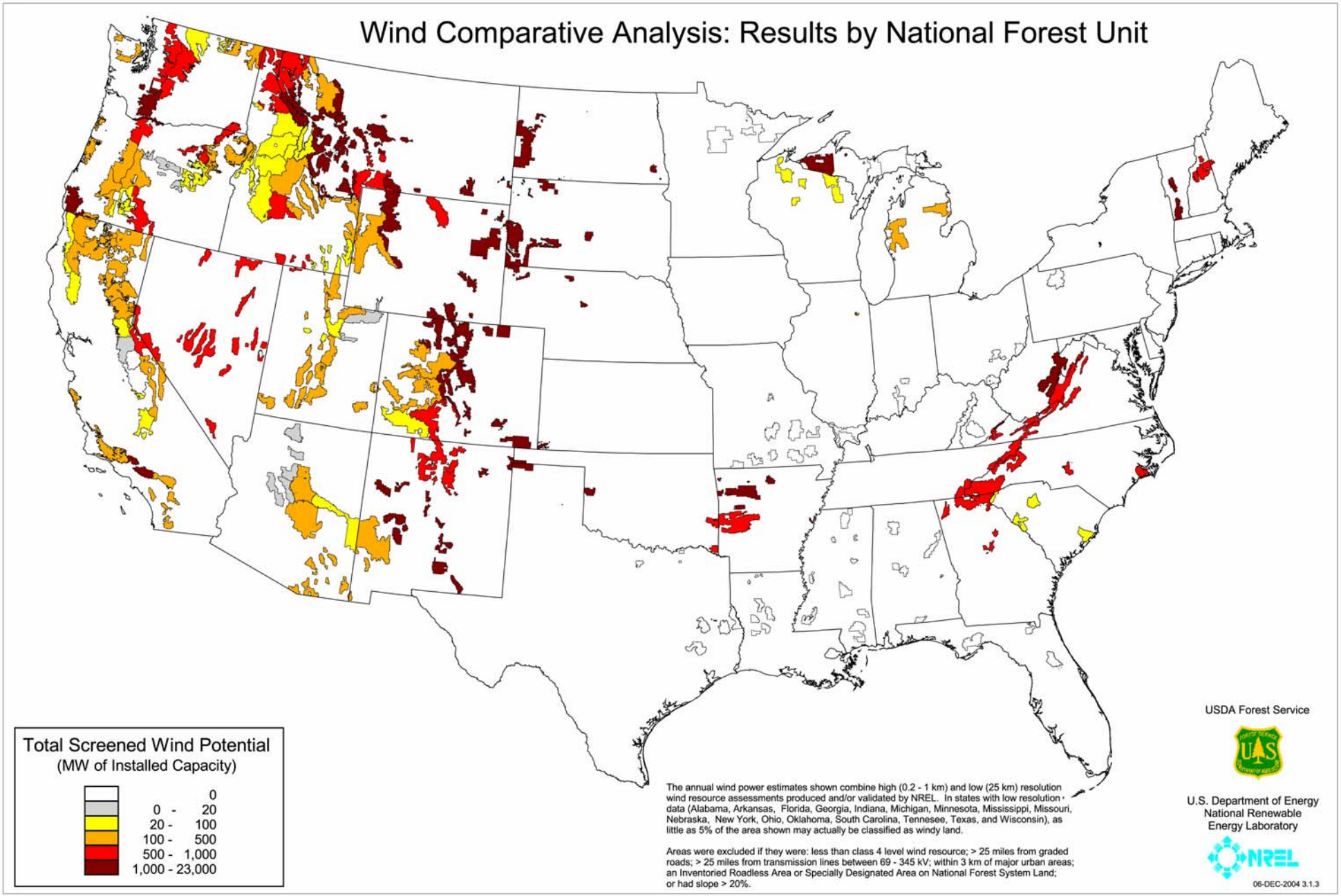
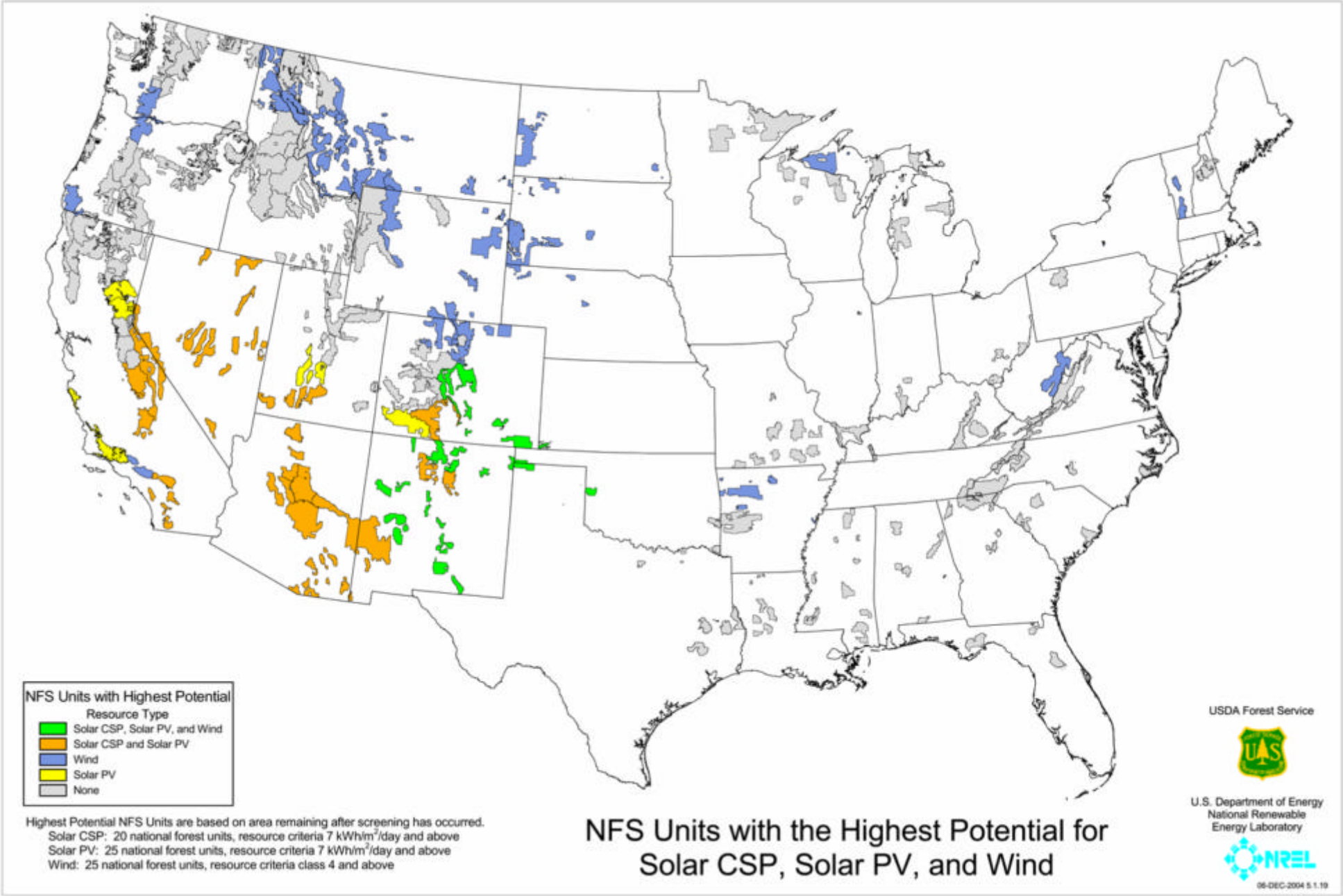

Wind Comparative Analysis: Results by National Forest Unit
Total Screened Wind Potential
(MW of Installed Capacity)
0
0 - 20
20 - 100
100 - 500
500 - 1,000
1,000 - 23,000
The annual wind power estimates shown combine high (0.2 - 1 km) and low (25 km) resolution wind resource assessments produced and/or validated by NREL. In states with low resolution data (Alabama, Arkansas, Florida, Georgia, Indiana, Michigan, Minnesota, Mississippi, Missouri, Nebraska, New York, Ohio, Oklahoma, South Carolina, Tennesee, Texas, and Wisconsin), as little as 5% of the area shown may actually be classified as windy land.
Areas were excluded if they were: less than class 4 level wind resource; > 25 miles from graded roads; > 25 miles from transmission lines between 69 - 345 kV; within 3 km of major urban areas; an Inventoried Roadless Area or Specially Designated Area on National Forest System Land; or had slope > 20%.
USDA Forest Service
U.S. Department of Energy
National Renewable
Energy Laboratory
NREL
06-DEC-2004 3.1.3


NFS Units with Highest Potential
Resource Type
Solar CSP, Solar PV, and Wind
Solar CSP and Solar PV
Wind
Solar PV
None
Highest Potential NFS Units are based on area remaining after screening has occurred.
Solar CSP: 20 national forest units, resource criteria 7 kWh/m²/day and above
Solar PV: 25 national forest units, resource criteria 7 kWh/m²/day and above
Wind: 25 national forest units, resource criteria class 4 and above
NFS Units with the Highest Potential for
Solar CSP, Solar PV, and Wind
USDA Forest Service
U.S. Department of Energy
National Renewable
Energy Laboratory
NREL
06-DEC-2004 5.1.19

Detailed Description

and Data Sets for GIS Maps

Resource Data

Solar

This report utilizes two solar datasets: a national solar resource assessment for the United States at a resolution of approximately 40 km by 40 km and a regional solar resource assessment for the southwestern United States at a resolution of approximately 10 km by 10 km. The CSP analysis utilized direct normal data, which represent concentrating systems that track the sun throughout the day, such as trough collectors or dishes. The PV analysis used data representing a 1-axis tracking flat plate collector with 0 degrees of tilt, oriented in a north-south direction.

The national dataset was produced by the Climatological Solar Radiation (CSR) Model, developed by NREL for DOE. The data are updated periodically; the most recent update was in mid-2001 and represents 14 collector configurations. The solar resource is represented as kilowatt-hours per square meter per day for each month (kWh/m^2/day), representing an average over 7 years (1985-1991). This model uses information on cloud cover, atmospheric water vapor and trace gases, and the amount of aerosols in the atmosphere to calculate the instantaneous insolation from both the sun and the sky. These can be combined to simulate the total radiation falling on a flat surface tilted in any direction. Where possible, existing ground-measurement stations were used to validate the model. Nevertheless, uncertainty is associated with the meteorological input to the model because some of the input parameters are not available at a 40-km resolution. As a result, the modeled values are believed to be accurate to approximately 10% of a true measured value within the grid cell.

The southwest regional dataset was developed by the State University of New York's GOES satellite solar model. This data provides monthly average and annual average daily total solar resource averaged over surface cells of approximately 10 km by 10 km in size. The solar resource value is represented as kWh/m^2/day, representing an average over 5 years (1998-2002). This model uses hourly satellite observed visible irradiance, atmospheric water vapor and trace gases, and the amount of aerosols in the atmosphere to calculate the monthly average daily total of the normal or beam insolation falling on a tracking concentrator pointed directly at the sun. Existing ground-measurement stations are used to validate the data where possible. The modeled values are accurate to approximately 12% of a true measured value within the grid cell as a result of the uncertainties associated with meteorological input to the model.

Because of terrain effects and other microclimate influences, local cloud cover can vary significantly even within a single grid cell. Furthermore, the uncertainty of the modeled estimates increases with distance from reliable measurement sources and with the complexity of the terrain. Concentrating solar collectors are much more sensitive to solar resource characteristics than flat-plate collectors, so these sources of uncertainty are more important to concentrator applications.

Wind

Wind resource data from many different sources was used in this analysis. Updated resource assessments of Arizona, California, Colorado, Connecticut, Delaware, Idaho, Illinois, Maine, Maryland, Massachusetts, Montana, Nevada, New Hampshire, New Jersey, New Mexico, North Carolina, North Dakota, Oregon, Pennsylvania, Rhode Island, South Dakota, Utah, Vermont, Virginia, Washington, West Virginia, and Wyoming were complete at the time the analysis was

performed. These assessments have a surface resolution that varies from 1 km by 1 km to 200 m by 200 m. Additional states assessments are underway by NREL, and several additional states will be complete by the time this report is published. Most of the updated assessments were produced using the Mesomap system and historical weather data in a collaborative effort between NREL and AWS TrueWind Solutions and were validated with available surface data by NREL and wind-energy meteorological consultants. The Illinois, North Dakota, and South Dakota wind-resource assessments were produced and validated solely by NREL. The assessment accuracy for both types of updated wind resource data is generally within 20% for wind power density for 80% of the areas. A significant difference between these two types of data is that the AWS assessments account for the effects of surface roughness, whereas the NREL assessments do not. In areas of high surface roughness (i.e., forest), the wind resource may be 1-2 power classes lower than shown. For more information, see http://www.windpoweringamerica.gov/.

For the remaining states, data from the *Wind Energy Resource Atlas of the United States* was used. This atlas was produced in 1987 by staff at the Pacific Northwest National Laboratory. The resolution of the gridded contiguous United States wind resource data is 1/4 degree of latitude by 1/3 degree of longitude, roughly 25 km by 25 km. Each grid cell was assigned a wind-power class, which applies only to sites within the grid cell that are well exposed to the wind. Depending on the terrain type within the grid cell, the portion of the grid cell that is exposed could vary from as little as 5% (ridge crests) to 95% (flat plains). The values were assigned by integrating several subjective factors: quantitative wind data; qualitative indicators of wind speed or power; the characteristics of exposed sites in various terrains; and familiarity with the meteorology, climatology, and topography of the region. As a result, the degree of certainty with which the wind power class can be specified depended on the abundance and quality of wind data, the complexity of the terrain, and the geographical variability of the resource. For more information, see http://rredc.nrel.gov/wind/pubs/atlas.

Reference:

Elliott, D. L., Holladay, C. G., Barchet, W. R., Foote, H.P., and Sandusky, W.F. 1987. *Wind Energy Resource Atlas of the United States.* Golden, CO: Solar Energy Research Institute.

Other GIS Data Used in the Analysis

Roads: The roads data were provided by the U.S. Forest Service Geospatial Service and Technology Center. It is a detailed dataset of roads on or near lands managed by the U.S. Forest Service. A subset of data was selected representing paved or graded roads for the analyses.

Populated Place Areas: United States populated place areas are represented in this data set, as identified by the U.S. Census Bureau. Population statistics are based on the 1990 Census. The data are distributed by Environmental Systems Research Institute, Inc.

Topography: Thirty arc second digital elevation model (DEM) data from the U.S. Geological Survey were used to calculate percent slope. The DEM has a nominal resolution of 1 km^2.

Transmission Lines: The transmission line data used are licensed by NREL from POWERmap, ©2004 Platts, a Division of the McGraw-Hill Companies. The data are generally complete down to 100 kilovolts (kV) and contain lower voltage lines in selected areas. The transmission lines have a nominal accuracy of 1 mile.

U.S. Forest Service management areas, Inventoried Roadless Areas, and Specially Designated Areas: This data was obtained from the U.S. Forest Service web sites (http://roadless.fs.fed.us/documents/feis/data/gis/coverages/index.shtml). The data used in the analyses was downloaded in January 2004.

National Forest Units with

Highest Solar and Wind Energy Potential

Table C-1: U.S. National Forest Units Listed Alphabetically with Maximum Development Potential:

C-1A	CSP
C-1B	PV
C-1C	Wind

Table C-2: U.S. National Forest Units Listed by State with Maximum Development Potential

Page C-22: GIS Map — All National Forest Units with Screened Solar CSP, Solar PV and Wind

Table C-1A. U.S. National Forest Units Listed Alphabetically with Maximum Development Potential – CSP

National Forest Unit	State	Area (acres)	Maximum Development Potential (MW)*
Apache-Sitgreaves	Arizona	180,086	36,017
Carson	New Mexico	2,323	465
Cibola	New Mexico	93,157	18,631
Cleveland	California	1,236	247
Coconino	Arizona	222,509	44,502
Coronado	Arizona	15,666	3,133
Dixie	Utah	6,523	1,305
Gila	New Mexico	74,585	14,917
Humboldt-Toiyabe	California	69	14
	Nevada	4,092	818
Humboldt-Toiyabe Total		*4,161*	*832*
Inyo	California	12,474	2,495
	Nevada	1,236	247
Inyo Total		*13,709*	*2,742*
Kaibab	Arizona	78,944	15,789
Lincoln	New Mexico	2,224	445
Pike-San Isabel	Colorado	247	49
Prescott	Arizona	75,583	15,117
Rio Grande	Colorado	3,064	613
San Bernardino	California	3,647	729
Santa Fe	New Mexico	14,490	2,898
Sequoia	California	979	196
Sierra	California	237	47
Tonto	Arizona	51,456	10,291

* Assuming 1 MW per 5 acres.

Table C-1B. U.S. National Forest Units Listed Alphabetically with Maximum Development Potential – PV

National Forest Unit	State	Area (acres)	Maximum Development Potential (MW)*
Angeles	California	2,115	423
Apache-Sitgreaves	Arizona	184,208	36,842
Carson	Colorado	10	2
	New Mexico	37,589	7,518
Carson Total		*37,599*	*7,520*
Cibola	New Mexico	189,150	37,830
	Texas	203,195	40,639
Cibola Total		*392,345*	*78,469*
Cleveland	California	3,954	791
Coconino	Arizona	230,900	46,180
Coronado	Arizona	17,337	3,467
Dixie	Utah	38,063	7,613
Eldorado	California	425	85
Fishlake	Utah	2,224	445
Gila	New Mexico	89,401	17,880
Grand Mesa-Uncompahgre-Gunnison	Colorado	494	99
Humboldt-Toiyabe	California	2,372	474
	Nevada	61,686	12,337
Humboldt-Toiyabe Total		*64,058*	*12,812*
Inyo	California	67,854	13,571
	Nevada	1,483	297
Inyo Total		*69,336*	*13,867*

Table C-1B (continued). U.S. National Forest Units Listed Alphabetically with Maximum Development Potential – PV

National Forest Unit	State	Area (acres)	Maximum Development Potential (MW)*
Kaibab	Arizona	109,248	21,850
Lake Tahoe Managment Unit	California	909	182
	Nevada	208	42
Lake Tahoe Managment Unit Total		*1,117*	*223*
Lassen	California	692	138
Lincoln	New Mexico	24,038	4,808
Los Padres	California	11,040	2,208
Manti-La Sal	Utah	1,483	297
Pike-San Isabel	Colorado	448,832	89,766
	Kansas	107,815	21,563
Pike-San Isabel Total		*556,647*	*111,329*
Plumas	California	8,510	1,702
Prescott	Arizona	79,942	15,988
Rio Grande	Colorado	10,042	2,008
San Bernardino	California	4,557	911
San Juan	Colorado	24,413	4,883
Santa Fe	New Mexico	34,979	6,996
Sequoia	California	5,347	1,069
Sierra	California	7,116	1,423
Stanislaus	California	1,700	340
Tahoe	California	7,334	1,467
Tonto	Arizona	57,021	11,404

* Assuming 1 MW per 5 acres.

Table C-1C. U.S. National Forest Units Listed Alphabetically with Maximum Development Potential – Wind

National Forest Unit	State	Area (acres)	Maximum Development Potential (MW)*
Angeles	California	71,560	1,448
Apache-Sitgreaves	Arizona	3,341	68
Arapaho-Roosevelt	Colorado	407,464	8,245
Ashley	Utah	316	6
	Wyoming	10	0
Ashley Total		*326*	*7*
Beaverhead-Deerlodge	Montana	84,854	1,717
Bighorn	Wyoming	33,447	677
Bitterroot	Montana	2,580	52
Black Hills	South Dakota	657,711	13,309
	Wyoming	9,350	189
Black Hills Total		*667,061*	*13,498*
Boise	Idaho	4,211	85
Bridger-Teton	Wyoming	5,061	102
Caribou	Idaho	3,944	80
Carson	New Mexico	46,178	934
Chattahoochee-Oconee	Georgia	33,075	669
Chequamegon-Nicolet	Georgia	3,398	69

Table C-1C (continued). U.S. National Forest Units Listed Alphabetically with Maximum Development Potential – Wind

National Forest Unit	State	Area (acres)	Maximum Development Potential (MW)*
Cherokee	Tennessee	42,321	856
Cibola	New Mexico	12,750	258
	Oklahoma	138,887	2,810
	Texas	88,252	1,786
Cibola Total		*239,889*	*4,854*
Clearwater	Idaho	2,036	41
Cleveland	California	14,727	298
Coconino	Arizona	6,543	132
Colville	Washington	8,303	168
Coronado	Arizona	9,479	192
Custer	Montana	38,557	780
	South Dakota	31,372	635
Custer Total		*69,929*	*1,415*
Dakota Prairie Grasslands	North Dakota	836,453	16,925
	South Dakota	292,804	5,925
Dakota Prairie Grasslands Total		*1,129,257*	*22,850*
Deschutes	Oregon	17,811	360
Dixie	Utah	7,591	154

Table C-1C (continued). U.S. National Forest Units Listed Alphabetically with Maximum Development Potential – Wind

National Forest Unit	State	Area (acres)	Maximum Development Potential (MW)*
Eldorado	California	1,443	29
Fishlake	Utah	13,077	265
Flathead	Montana	16,813	340
Francis Marion-Sumter	South Carolina	4,520	91
Fremont	Oregon	29,800	603
Gallatin	Montana	49,410	1,000
George Washington	Virginia	29,069	588
	West Virginia	6,741	136
George Washington Total		*35,810*	*725*
Gifford Pinchot	Washington	52,059	1,053
Gila	New Mexico	7,136	144
Grand Mesa-Uncompahgre-Gunnison	Colorado	11,297	229
Green Mountain and Finger Lakes	New York	259	5
	Vermont	53,344	1,079
Green Mountain and Finger Lakes Total		*53,603*	*1,085*
Helena	Montana	57,792	1,169

Table C-1C (continued). U.S. National Forest Units Listed Alphabetically with Maximum Development Potential – Wind

National Forest Unit	State	Area (acres)	Maximum Development Potential (MW)*
Humboldt-Toiyabe	California	8,767	177
	Nevada	24,987	506
Humboldt-Toiyabe Total		*33,754*	*683*
Huron-Manistee	Michigan	5,645	114
Idaho Panhandle	Idaho	47,582	963
	Montana	1,690	34
	Washington	99	2
Idaho Panhandle Total		*49,371*	*999*
Inyo	California	7,621	154
Jefferson	Kentucky	1,275	26
	Virginia	23,465	475
	West Virginia	979	20
Jefferson Total		*25,718*	*520*
Kaibab	Arizona	929	19
Klamath	California	11,614	235
	Oregon	1,255	25
Klamath Total		*12,869*	*260*

Table C-1C (continued). U.S. National Forest Units Listed Alphabetically with Maximum Development Potential – Wind

National Forest Unit	State	Area (acres)	Maximum Development Potential (MW)*
Kootenai	Idaho	613	12
	Montana	27,636	559
Kootenai Total		*28,248*	*572*
Lake Tahoe Managment Unit	California	1,483	30
	Nevada	3,568	72
Lake Tahoe Managment Unit Total		*5,051*	*102*
Lassen	California	7,818	158
Lewis & Clark	Montana	80,189	1,623
Lincoln	New Mexico	91,101	1,843
Lolo	Montana	49,548	1,003
Los Padres	California	13,699	277
Malheur	Oregon	1,661	34
Manti-La Sal	Colorado	49	1
	Utah	19,471	394
Manti-La Sal Total		*19,521*	*395*

Table C-1C (continued). U.S. National Forest Units Listed Alphabetically with Maximum Development Potential – Wind

National Forest Unit	State	Area (acres)	Maximum Development Potential (MW)*
Medicine Bow-Routt	Colorado	15,696	318
	Wyoming	870,859	17,622
Medicine Bow-Routt Total		*886,555*	*17,939*
Mendocino	California	1,878	38
Modoc	California	19,155	388
Monongahela	West Virginia	63,159	1,278
Mt. Baker-Snoqualmie	Washington	28,911	585
Mt. Hood	Oregon	47,621	964
National Forests in North Carolina	North Carolina	34,707	702
Nebraska	Nebraska	72,108	1,459
	South Dakota	889,303	17,995
Nebraska Total		*961,411*	*19,454*
Nez Perce	Idaho	3,044	62
Ochoco	Oregon	929	19
Okanogan	Washington	2,491	50
Olympic	Washington	14,470	293
Ottawa	Michigan	57,175	1,157

Table C-1C (continued). U.S. National Forest Units Listed Alphabetically with Maximum Development Potential – Wind

National Forest Unit	State	Area (acres)	Maximum Development Potential (MW)*
Ouachita	Arkansas	40,086	811
	Oklahoma	2,828	57
Ouachita Total		*42,913*	*868*
Ozark-St. Francis	Arkansas	50,844	1,029
Payette	Idaho	2,738	55
Pike-San Isabel	Colorado	418,202	8,462
	Kansas	13,042	264
Pike-San Isabel Total		*431,244*	*8,726*
Plumas	California	15,261	309
Prescott	Arizona	455	9
Rio Grande	Colorado	34,663	701
Rogue River	California	1,364	28
	Oregon	10,438	211
Rogue River Total		*11,801*	*239*
Salmon-Challis	Idaho	7,324	148
San Bernardino	California	23,059	467
San Juan	Colorado	3,519	71
Santa Fe	New Mexico	36,630	741

Table C-1C (continued). U.S. National Forest Units Listed Alphabetically with Maximum Development Potential – Wind

National Forest Unit	State	Area (acres)	Maximum Development Potential (MW)*
Sawtooth	Idaho	27,873	564
	Utah	6,029	122
Sawtooth Total		*33,902*	*686*
Sequoia	California	3,657	74
Shasta-Trinity	California	16,931	343
Shoshone	Wyoming	55,014	1,113
Siskiyou	California	1,522	31
	Oregon	59,017	1,194
Siskiyou Total		*60,540*	*1,225*
Siuslaw	Oregon	20,262	410
Six Rivers	California	1,759	36
Stanislaus	California	40	1
Tahoe	California	11,307	229
Targhee	Idaho	4,982	101
	Wyoming	504	10
Targhee Total		*5,486*	*111*
Tonto	Arizona	12,869	260
Uinta	Utah	1,265	26

Table C-1C (continued). U.S. National Forest Units Listed Alphabetically with Maximum Development Potential – Wind

National Forest Unit	State	Area (acres)	Maximum Development Potential (MW)*
Umatilla	Oregon	21,330	432
	Washington	9,330	189
Umatilla Total		*30,660*	*620*
Umpqua	Oregon	14,777	299
Wallowa-Whitman	Oregon	8,095	164
Wasatch-Cache	Utah	7,087	143
Wenatchee	Washington	40,297	815
White Mountain	Maine	1,522	31
	New Hampshire	36,185	732
White Mountain Total		*37,707*	*763*
White River	Colorado	15,735	318
Willamette	Oregon	17,396	352
Winema	Oregon	1,404	28

* Installed nameplate capacity, assuming ~1 MW per 50 acres.

Table C-2. U.S. National Forest Units Listed by State with Maximum Development Potential

State	National Forest Unit	Solar CSP Maximum Development Potential (MW)*	Solar PV Maximum Development Potential (MW)*	Wind Maximum Development Potential (MW)**	Total Maximum Development Potential (MW)**
Arizona	Apache-Sitgreaves	36,017	36,842	68	72,927
	Coconino	44,502	46,180	132	90,814
	Coronado	3,133	3,467	192	6,792
	Kaibab	15,789	21,850	19	37,657
	Prescott	15,117	15,988	9	31,114
	Tonto	10,291	11,404	260	21,956
Arizona Total		*124,849*	*135,731*	*680*	261,260
Arkansas	Ouachita			811	811
	Ozark-St. Francis			1,029	1,029
Arkansas Total		*0*	*0*	*1,840*	1,840
California	Angeles		423	1,448	1,871
	Cleveland	247	791	298	1,336
	Eldorado		85	29	114
	Humboldt-Toiyabe	14	474	177	666
	Inyo	2,495	13,571	154	16,220
	Klamath			235	235
	Lake Tahoe Managment Unit		182	30	212
	Lassen		138	158	297
	Los Padres		2,208	277	2,485
	Mendocino			38	38

Table C-2. (continued). U.S. National Forest Units Listed by State with Maximum Development Potential

State	National Forest Unit	Solar CSP Maximum Development Potential (MW)*	Solar PV Maximum Development Potential (MW)*	Wind Maximum Development Potential (MW)**	Total Maximum Development Potential (MW)**
	Modoc			388	388
	Plumas		1,702	309	2,011
	Rogue River			28	28
	San Bernardino	729	911	467	2,107
	Sequoia	196	1,069	74	1,339
	Shasta-Trinity			343	343
	Sierra	47	1,423		1,471
California (cont'd)	Siskiyou			31	31
	Six Rivers			36	36
	Stanislaus		340	1	341
	Tahoe		1,467	229	1,696
California Total		*3,728*	*24,785*	*4,748*	33,262
Colorado	Arapaho-Roosevelt			8,245	8,245
	Carson		2		2
	Grand Mesa-Uncompahgre-Gunnison		99	229	327
	Manti-La Sal			1	1
	Medicine Bow-Routt			318	318
	Pike-San Isabel	49	89,766	8,462	98,278
	Rio Grande	613	2,008	701	3,323

Table C-2. (continued). U.S. National Forest Units Listed by State with Maximum Development Potential

State	National Forest Unit	Solar CSP Maximum Development Potential (MW)*	Solar PV Maximum Development Potential (MW)*	Wind Maximum Development Potential (MW)**	Total Maximum Development Potential (MW)**
	San Juan		4,883	71	4,954
	White River			318	318
Colorado Total		*662*	*96,758*	*18,345*	115,766
Georgia	Chattahoochee-Oconee			669	669
	Chequamegon-Nicolet			69	69
Georgia Total		*0*	*0*	*738*	738
Idaho	Boise			85	85
	Caribou			80	80
	Clearwater			41	41
	Idaho Panhandle			963	963
	Kootenai			12	12
	Nez Perce			62	62
	Payette			55	55
	Salmon-Challis			148	148
	Sawtooth			564	564
	Targhee			101	101
Idaho Total		*0*	*0*	*2,111*	2,111
Kansas	Pike-San Isabel		21,563	264	21,827
Kentucky	Jefferson			26	26
Maine	White Mountain			31	31

Table C-2. (continued). U.S. National Forest Units Listed by State with Maximum Development Potential

State	National Forest Unit	Solar CSP Maximum Development Potential (MW)*	Solar PV Maximum Development Potential (MW)*	Wind Maximum Development Potential (MW)**	Total Maximum Development Potential (MW)**
Michigan	Huron-Manistee			114	114
	Ottawa			1,157	1,157
Michigan Total		*0*	*21,563*	*1,592*	23,155
Montana	Beaverhead-Deerlodge			1,717	1,717
	Bitterroot			52	52
	Custer			780	780
	Flathead			340	340
	Gallatin			1,000	1,000
	Helena			1,169	1,169
	Idaho Panhandle			34	34
	Kootenai			559	559
	Lewis & Clark			1,623	1,623
	Lolo			1,003	1,003
Montana Total		*0*	*0*	*8,277*	8,277
Nebraska	Nebraska			1,459	1,459
Nevada	Humboldt-Toiyabe	818	12,337	506	13,661
	Inyo	247	297		544
	Lake Tahoe Managment Unit		42	72	114
Nevada Total		*1,065*	*12,675*	*578*	14,319
New Hampshire	White Mountain			732	732

Table C-2. (continued). U.S. National Forest Units Listed by State with Maximum Development Potential

State	National Forest Unit	Solar CSP Maximum Development Potential (MW)*	Solar PV Maximum Development Potential (MW)*	Wind Maximum Development Potential (MW)**	Total Maximum Development Potential (MW)**
New Mexico	Carson	465	7,518	934	8,917
	Cibola	18,631	37,830	258	56,719
	Gila	14,917	17,880	144	32,941
	Lincoln	445	4,808	1,843	7,096
	Santa Fe	2,898	6,996	741	10,635
New Mexico Total		*37,356*	*75,031*	*3,921*	116,308
New York	Green Mountain and Finger Lakes			5	5
North Carolina	National Forests in North Carolina			702	702
North Dakota	Dakota Prairie Grasslands			16,925	16,925
Oklahoma	Cibola			2,810	2,810
	Ouachita			57	57
Oklahoma Total		*0*	*0*	*2,868*	2,868
Oregon	Deschutes			360	360
	Fremont			603	603
	Klamath			25	25
	Malheur			34	34
	Mt. Hood			964	964
	Ochoco			19	19
	Rogue River			211	211
	Siskiyou			1,194	1,194

Table C-2. (continued). U.S. National Forest Units Listed by State with Maximum Development Potential

State	National Forest Unit	Solar CSP Maximum Development Potential (MW)*	Solar PV Maximum Development Potential (MW)*	Wind Maximum Development Potential (MW)**	Total Maximum Development Potential (MW)**
	Siuslaw			410	410
	Umatilla			432	432
	Umpqua			299	299
	Wallowa-Whitman			164	164
	Willamette			352	352
	Winema			28	28
Oregon Total		*0*	*0*	*5,095*	5,095
South Carolina	Francis Marion-Sumter			91	91
South Dakota	Black Hills			13,309	13,309
	Custer			635	635
	Dakota Prairie Grasslands			5,925	5,925
	Nebraska			17,995	17,995
South Dakota Total		*0*	*0*	*37,863*	37,863
Tennessee	Cherokee			856	856
Texas	Cibola		40,639	1,786	42,425
Utah	Ashley			6	6
	Dixie	1,305	7,613	154	9,071
	Fishlake		445	265	709
	Manti-La Sal		297	394	691
	Sawtooth			122	122

Table C-2. (continued). U.S. National Forest Units Listed by State with Maximum Development Potential

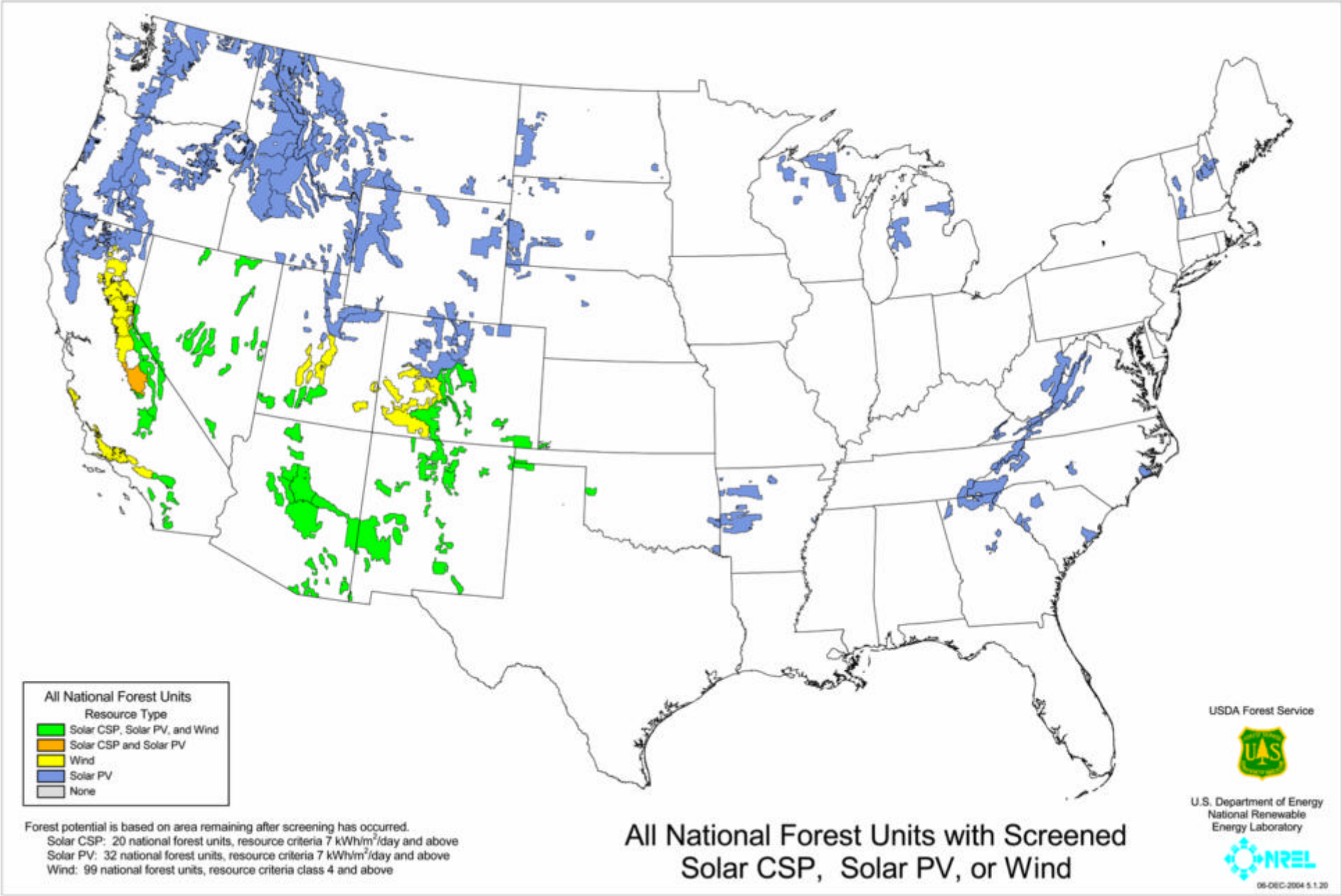
State	National Forest Unit	Solar CSP Maximum Development Potential (MW)*	Solar PV Maximum Development Potential (MW)*	Wind Maximum Development Potential (MW)**	Total Maximum Development Potential (MW)**
	Uinta			26	26
	Wasatch-Cache			143	143
Utah Total		*1,305*	*8,354*	*1,110*	10,768
Vermont	Green Mountain and Finger Lakes			1,079	1,079
Virginia	George Washington			588	588
	Jefferson			475	475
Virginia Total		*0*	*0*	*1,063*	1,063
Washington	Colville			168	168
	Gifford Pinchot			1,053	1,053
	Idaho Panhandle			2	2
	Mt. Baker-Snoqualmie			585	585
	Okanogan			50	50
	Olympic			293	293
	Umatilla			189	189
	Wenatchee			815	815
Washington Total		*0*	*0*	*3,156*	3,156
West Virginia	George Washington			136	136
	Jefferson			20	20
	Monongahela			1,278	1,278

Table C-2. (continued). U.S. National Forest Units Listed by State with Maximum Development Potential

State	National Forest Unit	Solar CSP Maximum Development Potential (MW)*	Solar PV Maximum Development Potential (MW)*	Wind Maximum Development Potential (MW)**	Total Maximum Development Potential (MW)**
West Virginia Total		*0*	*0*	*1,434*	1,434
Wyoming	Ashley			0	0
	Bighorn			677	677
	Black Hills			189	189
	Bridger-Teton			102	102
	Medicine Bow-Routt			17,622	17,622
	Shoshone			1,113	1,113
	Targhee			10	10
Wyoming Total		*0*	*0*	*19,714*	19,714

*** Assuming 1 MW per 5 acres**

**** Installed nameplate capacity, assuming ~1 MW per 50 acres**


All National Forest Units
Resource Type
Solar CSP, Solar PV, and Wind
Solar CSP and Solar PV
Wind
Solar PV
None
Forest potential is based on area remaining after screening has occurred.
Solar CSP: 20 national forest units, resource criteria 7 kWh/m²/day and above
Solar PV: 32 national forest units, resource criteria 7 kWh/m²/day and above
Wind: 99 national forest units, resource criteria class 4 and above
All National Forest Units with Screened
Solar CSP, Solar PV, or Wind
USDA Forest Service
U.S. Department of Energy
National Renewable
Energy Laboratory
NREL
06-DEC-2004 5.1.20

State Policies and Financial Incentives

for Renewable Energy

Federal Policies

Modified Accelerated Cost Recovery System (MACRS) with 50% Bonus Depreciation

Under the Modified Accelerated Cost Recovery System (MACRS), businesses can recover investments in solar, wind, and geothermal property through depreciation deductions. The MACRS establishes a set of class lives for various types of property, ranging from 3 to 50 years, over which the property may be depreciated. For solar, wind, and geothermal property placed in service after 1986, the current MACRS property class is 5 years.

In addition to the MACRS depreciation, Section 101 of the Job Creation and Worker Assistance Act of 2002 (http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=107_cong_public_laws&docid=f:publ147.107.pdf) added Subsection 168(k) to the tax code relating to the accelerated cost-recovery system. This provision allowed businesses to take an additional 30% depreciation on solar, wind, and geothermal property in the first year. In May 2003, The Job Creation and Tax Relief Reconciliation Act of 2003 was signed into law, increasing the bonus depreciation to 50% in the first year that the equipment is purchased and placed into service.

Note that many states either have not adopted the federal bonus depreciation or have specifically "uncoupled" their state tax depreciation schedules from the new federal rules.

Renewable Electricity Production Tax Credit

Eligible Technologies: Solar Thermal Electric, Photovoltaics, Landfill Gas, Wind, Biomass, Geothermal Electric, Municipal Solid Waste, Cogeneration, Refined Coal, Anaerobic Digestion, Small Hydroelectric

Amount: 1.8 cents/kWh for wind, solar, geothermal, closed-loop biomass; 0.9 cents/kWh for others

Terms: First 10 years of operation for wind, closed-loop biomass; first 5 years for other technologies

Website: http://www.irs.gov/pub/irs-pdf/f8835.pdf

Note, however, that owners of solar and geothermal projects who claim the 10% federal business energy tax credit (http://www.dsireusa.org/library/includes/incentive2.cfm?Incentive_Code=US02F&State=Federal&currentpageid=1) may NOT also claim this production tax credit.

Solar and Geothermal Business Energy Tax Credit

Eligible Technologies: Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics, Geothermal Electric

Amount: 10%

Max. Limit: $25,000 per year, plus 25% of the total tax remaining after the credit is taken

Terms: Credit may be carried back to the three preceding years and then carried forward for 15 years

State Policies

Arizona

Production Incentive – Green Tag Purchase Program

Eligible Technologies: Solar Thermal Electric, Photovoltaics, Wind, Biomass, Geothermal Electric, Small Hydroelectric, Renewable Fuels

Amount: $1 to $100 per MWh total production; varies by technology and contract length

Terms: Any size system, grid tied, new renewable (January 1, 1999, or later)

Website: http://www.mainstayenergy.com/

Mainstay Energy is a private company offering customers who install, or have installed, renewable energy systems the opportunity to sell the green-tag RECs associated with the energy generated by these systems. These green tags will be brought to market as Green-e* (http://www.green-e.org/) certified products. Through the Mainstay Energy Rewards Program, participating customers receive regular, recurring payments.

The amount of the payments depends on the type of renewable energy technology, the production of electricity by that system, and the length of the contract period. Mainstay offers 3-, 5-, and 10-year purchase contracts. The longer the contract period, the greater the incentive payment on a $/kWh basis. Payments are made quarterly.

Generation Disclosure

The Arizona Corporation Commission adopted disclosure provisions as part of its 1996 Retail Electric Competition Rules. Under the disclosure provisions, all retail suppliers of electricity must disclose composition, fuel mix, and emissions characteristics upon request.

Green Power Purchasing

Scottsdale – local government buildings using photovoltaics

Net Metering

Salt River Project

Tucson Electric Power Company

Renewables Portfolio Standard

Under the Environmental Portfolio Standard (EPS), regulated utilities in the state are required to provide a certain percentage of their electricity from renewable energy. The standard begins with 0.2% renewables for 2001 and increases to 1.1% renewables in 2007 through 2012. Of these amounts, solar-electric must make up 50% in 2001, increasing to 60% for 2004 through 2012.

Applicable technologies include solar-electric (PV), solar water heating and solar air conditioning, landfill gas, wind, and biomass. Arizona Public Service Company requested and received a rule waiver that would allow it to meet a portion of its EPS requirements from geothermal resources.

California

Corporate Solar and Wind Energy Tax Credit

California's Solar or Wind Energy System Credit (SB17x2) was approved by the Governor on October 8, 2001. The law provides personal and corporate income tax credits for the purchase and installation of photovoltaic or wind-driven systems with a peak generating capacity of up to 200 kilowatts. After January 1, 2004, and before January 1, 2006, the tax credit is equal to 7.5% of the net installed system cost after deducting the value of any municipal-, state-, or federal-sponsored financial incentives, or $4.50 per watt of rated peak generating capacity, whichever is less. A 15% tax credit was available January 1, 2001, through December 31, 2003. A 5-year warranty is required of each system. Taxpayers claiming the credit cannot sell the electricity produced by the system, but may utilize California's net metering law, if eligible.

Production Incentive – Supplemental Energy Payments

Eligible Technologies: Solar Thermal Electric, Photovoltaics, Landfill Gas, Wind, Biomass, Hydroelectric, Geothermal Electric, Fuel Cells, Municipal Solid Waste, Anaerobic Digestion, Tidal Energy, Wave Energy, Ocean Thermal

Amount: For above-market costs as compared to a market-price referent (subject to determination by the Energy Commission)

Terms: Three- to 10-year contracts

Website: http://www.energy.ca.gov/portfolio/

Solar Property Tax Exemption: According to the California Revenue and Taxation Code, section 73, active solar energy systems installed between January 1, 1999, and January 1, 2006, are not subject to property taxes.

Generation Disclosure

California's energy suppliers must disclose to all customers the energy resource mix used in generation. Providers must use a standard label created by the California Energy Commission (CEC), and this information must be provided to end-use customers at least four times per year.

Green Power Purchasing

Davis – local government buildings using photovoltaics

Los Angeles – local government buildings

San Diego – local government buildings using solar water heat, solar thermal electric, photovoltaics, landfill gas, wind, biomass, geothermal electric, fuel cells, municipal solid waste, digester gas, small hydroelectric, tidal energy, wave energy, and ocean thermal

Santa Monica – local government buildings using geothermal electric

Net Metering

California's net-metering law requires that all three of California's investor-owned electric utilities (PG&E, SCE, and SDG&E) and rural cooperatives, allow net metering for all customer classes for systems up to 1,000 kW (1 MW). Municipal utilities are allowed to permit either net-metering or co-metering. Net-metering customers are allowed to carry forward kWh credits for up to 12 months. Any net excess generation at the end of each 12-month period is granted to the utility. Customers subject to time-of-use (TOU) rates are entitled to deliver electricity back to the system for the same time-of-use (including real-time) price that they pay for power purchases. However, TOU customers choosing to net meter must pay for the metering equipment capable of making such measurements. Eligible technologies include photovoltaics, landfill gas, wind, fuel cells, anaerobic digestion.

Public Benefits Fund

California set the bar for all other renewable energy funds with the creation of a $540 million fund for renewables with its electric industry restructuring legislation (AB 1890) back in 1996. The success of that program lead to legislation to extend that funding—at the same annual levels—another 10 years, through 2012, creating an additional $1.35 billion in renewables funding.

This extended funding was enabled through Assembly Bill 995, which passed in September 2000. The California Energy Commission's (CEC) authority to administer the extended fund was established in 2002 by Senate Bill 1038. The initial funding was collected from 1998 to 2001 from customers of the state's three investor-owned utilities—SDG&E, SCE, and PG&E—which must pay specified amounts each year. The extended funding continues to be collected from the same entities. The CEC manages the renewables funds.

Renewables Portfolio Standard

Legislation enacting California's Renewable Portfolio Standard (RPS) (SB 1078) was signed by the Governor of California on September 12, 2002. This legislation, which requires retail sellers of electricity to purchase 20% of their electricity from renewable sources by 2017, establishes California as having the most aggressive RPS in the country. Renewable sources include biomass, solar thermal, photovoltaics, wind, geothermal, fuel cells using renewable fuels, small hydropower of 30 MW or less, digester gas, landfill gas, ocean wave, ocean thermal, and tidal current. Municipal solid waste is generally only eligible if it is converted to a clean burning fuel using a non-combustion thermal process. There are restrictions for some of these technologies.

Colorado

Production Incentive – Green Tag Purchase Program

Eligible Technologies: Solar Thermal Electric, Photovoltaics, Wind, Biomass, Geothermal Electric, Small Hydroelectric, Renewable Fuels

Amount: $1 to $100 per MWh total production; varies by technology and contract length

Terms: Any size system, grid tied, new renewable (January 1, 1999 or later)

Website: http://www.mainstayenergy.com/

Mainstay Energy is a private company offering customers who install, or have installed, renewable energy systems the opportunity to sell the green tags RECs associated with the energy generated by these systems. These green tags will be brought to market as Green-e* (http://www.green-e.org/) certified products. Through the Mainstay Energy Rewards Program, participating customers receive regular, recurring payments.

The amount of the payments depends on the type of renewable energy technology, the production of electricity by that system, and the length of the contract period. Mainstay offers 3-, 5-, and 10-year purchase contracts. The longer the contract period, the greater the incentive payment on a $/kWh basis. Payments are made quarterly.

Generation Disclosure

Colorado is one of several states to require disclosure without having restructured its electricity market. In January 1999, the Colorado Public Utility Commission (PUC) adopted regulations requiring the state's investor-owned utilities (IOUs) to disclose information regarding their fuel mix to retail customers. Utilities with a total system load of more than 100 MW are required to provide this information as a bill insert or as a separate mailing twice annually, beginning October 1999.

The PUC provided a suggested format for the disclosure. Fuel mix percentages are to be based on the power supply mix for the previous calendar year. Supporting documentation concerning

the calculations used to determine the power supply mix percentages must be submitted to the PUC for approval.

Green Power Purchasing

Aspen – local government buildings using wind

Boulder – local government buildings using wind

Net Metering

Aspen Electric/Holy Cross Electric

Fort Collins Utilities

Gunnison County Electric

Xcel Energy

Renewables Portfolio Standard

State

The initiative requires Colorado utilities with 40,000 or more customers to generate or purchase a percentage of their electricity from renewable sources according to the following schedule:

- 3% from 2007 through 2010
- 6% from 2011 through 2014
- 10% by 2015 and thereafter.

Of the electricity generated each year from renewable sources, at least 4% must come from solar technologies. At least one-half of this percentage must come from solar systems located on-site at customers' facilities. Other eligible technologies include wind, geothermal heat, biomass facilities that burn nontoxic plants, landfill gas, animal waste, small hydroelectric, and hydrogen fuel cells. Energy generated in Colorado is favored: each kWh of renewable electricity generated in-state will be counted as 1.25 kWh for the purposes of meeting this standard.

Fort Collins

Electric Energy Supply Policy - Standard: Additional 2% by 2004; 15% by 2017

Georgia

Production Incentive - Green Tag Purchase Program

Eligible Technologies: Solar Thermal Electric, Photovoltaics, Wind, Biomass, Geothermal Electric, Small Hydroelectric, Renewable Fuels

Amount: $1 to $100 per MWh total production; varies by technology and contract length

Terms: Any size system, grid tied, new renewable (January 1, 1999, or later)

Website: http://www.mainstayenergy.com/

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The amount of the payments depends on the type of renewable energy technology, the production of electricity by that system, and the length of the contract period. Mainstay offers 3-, 5-, and 10-year purchase contracts. The longer the contract period, the greater the incentive payment on a $/kWh basis. Payments are made quarterly.

TVA – Green Power Switch Generation Partners Program

Eligible Technologies: Photovoltaics, Wind

Amount: $500 (residential only) plus $0.15 per kWh for 10 years (residential and commercial)

Terms: $500 payment available until the program capacity reaches 150 kW

Website: http://www.gpsgenpartners.com

TVA and participating power distributors currently offer a dual-metering option to residential and small-commercial consumers (non-demand-metered) through the Green Power Switch Generation Partners program. The output (green power) generated from this program will be counted as a TVA Green Power Switch resource.

Through this program, TVA will purchase the entire output of a qualifying system at $0.15 per kWh through a participating power distributor, and the consumer will receive a credit for the power generated. Participation in this program is entirely up to the discretion of the power distributor. As of June 2004, about a dozen distributors have signed up for the program. Thus far, the program includes several residential solar participants and one 20-kW wind project.

Net Metering

While resembling a standard net metering law on the surface, Georgia's legislation helps paves the way for a new relationship between utility and customer-generator by combining net metering with green pricing. Utilities will purchase energy until renewable capacity reaches 0.2% of the utility's system peak. Eligible technologies include PV, fuel cells, and wind systems up to 10 kW for residential applications and 100 kW for commercial applications. The key to the law is a provision that power flows to and from the home are separately measured with the intent that customers will see added value because utilities can package the excess kilowatt-hours as

part of green-pricing programs. This is the first state law designed to accommodate the net metering-green power symbiosis.

Idaho

Production Incentive – Green Tag Purchase Program

Eligible Technologies: Solar Thermal Electric, Photovoltaics, Wind, Biomass, Geothermal Electric, Small Hydroelectric, Renewable Fuels

Amount: $1 to $100 per MWh total production; varies by technology and contract length

Terms: Any size system, grid tied, new renewable (January 1, 1999, or later)

Website: http://www.mainstayenergy.com/

Mainstay Energy is a private company offering customers who install, or have installed, renewable energy systems the opportunity to sell the green tag RECs associated with the energy generated by these systems. These green tags will be brought to market as Green-e* (http://www.green-e.org/) certified products. Through the Mainstay Energy Rewards Program, participating customers receive regular, recurring payments.

The amount of the payments depends on the type of renewable energy technology, the production of electricity by that system, and the length of the contract period. Mainstay offers 3-, 5-, and 10-year purchase contracts. The longer the contract period, the greater the incentive payment on a $/kWh basis. Payments are made quarterly.

Net Metering

Idaho does not have a state-wide net-metering rule. However, all three investor-owned utilities—Avista Utilities, Idaho Power Company, and Utah Power & Light Company (owned by PacifiCorp)—have net-metering tariffs on file with the Idaho Public Utilities Commission.

Avista, which serves the northern part of Idaho, allows net metering to all customers generating up to 25 kW of electricity using solar, wind, biomass, hydropower, or fuel cells. Enrollment is limited to 0.1% of 1996 peak demand (1.52 MW). Excess generation is credited to the customer's monthly bill and used to reduce the bill for the following period. At the end of the year, any remaining credits are granted to Avista.

Idaho Power made net metering available only to residential and small commercial customers generating up to 25 kW of wind, solar, biomass, hydro, or power from fuel cells. In August 2002, the PUC issued Order No. 29094 amending Idaho Power's Schedule 84 to include other schedules, such as large commercial and irrigation. This allows net-metered projects up to 100 kW for schedules other than residential and small commercial. Excess kWh generation per month is paid at 85% of the Mid-Columbia market price for non-firm energy. Total enrollment cannot exceed 2.9 MW (0.1%) of Idaho Power's peak demand in 2000.

Utah Power & Light Company allows net metering to residential and small-commercial customers generating up to 25 kW of electricity using solar, wind, biomass or hydropower, and to irrigation and large commercial customers generating up to 100 kW. Enrollment is limited to 0.1% of the company's Idaho retail peak demand in 2002.

Kansas

Production Incentive – Green Tag Purchase Program

Eligible Technologies: Solar Thermal Electric, Photovoltaics, Wind, Biomass, Geothermal Electric, Small Hydroelectric, Renewable Fuels

Amount: $1 to $100 per MWh total production; varies by technology and contract length

Terms: Any size system, grid tied, new renewable (January 1, 1999, or later)

Website: http://www.mainstayenergy.com/

Mainstay Energy is a private company offering customers who install, or have installed, renewable energy systems the opportunity to sell the green-tag RECs associated with the energy generated by these systems. These green tags will be brought to market as Green-e* (http://www.green-e.org/) certified products. Through the Mainstay Energy Rewards Program, participating customers receive regular, recurring payments.

The amount of the payments depends on the type of renewable energy technology, the production of electricity by that system, and the length of the contract period. Mainstay offers 3-, 5-, and 10-year purchase contracts. The longer the contract period, the greater the incentive payment on a $/kWh basis. Payments are made quarterly.

Renewable Energy Property Tax Exemption

This statute exempts renewable energy equipment from property taxes. Renewable energy includes wind, solar thermal electric, photovoltaic, biomass, hydropower, geothermal, and landfill gas resources or technologies that are actually and regularly used predominantly to produce and generate electricity.

Maine

Production Incentive – Green Tag Purchase Program

Eligible Technologies: Solar Thermal Electric, Photovoltaics, Wind, Biomass, Geothermal Electric, Small Hydroelectric, Renewable Fuels

Amount: 1.7 to 6.4 cents/kWh; varies by technology, contract length, and payment plan

Terms: Any size system, grid tied, new renewable (January 1, 1998, or later)

Website: http://www.mainstayenergy.com/

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Through the Mainstay Energy Rewards Program, participating customers in New England receive either quarterly production-based payments, or an up-front payment. The amount of the incentive is based on the type of renewable energy technology, the production of electricity by that system (or size, in the case of the up-front payment), and the length of the contract period. Mainstay offers 3-, 5-, and 10-year purchase contracts. The longer the contract period, the greater the incentive payment.

Generation Disclosure

Maine's restructuring legislation, effective May 29, 1997, called for the state's Public Utility Commission (PUC) to establish disclosure rules for retail electric billing and required that the Commission consider the use of standard billing information. By Orders issued February 23, 1999, and June 29, 1999, the PUC adopted Chapter 306 governing the disclosure by competitive electricity providers of price, contract, resource mix, and emissions information to customers in a uniform format.

Green Power Purchasing

Maine – state government buildings using biomass and small hydroelectric technologies

Net Metering

Eligible Technologies: Solar Thermal Electric, Photovoltaics, Wind, Biomass, Hydroelectric, Geothermal Electric, Fuel Cells, Municipal Solid Waste, Cogeneration, Tidal Energy

Limit on System Size: 100 kW

Limit on Overall Enrollment: None

Treatment of Net Excess: Credited to the following month, then granted to the utility at end of annual period with no compensation

Renewables Portfolio Standard

The State of Maine Public Utility Commission (PUC) adopted a Renewable Resource Portfolio Requirement rule requiring electric providers to supply at least 30% of their total retail electric sales in Maine with electricity from eligible renewable resources. Eligible resources must be a “small power production facility” that produces electricity using only a primary energy source of

biomass, waste, renewable resources, or a combination of these resources and has a production capacity of 80 MW or less, including any other facilities at the same site. A renewable resource may also be a generation facility of 100 MW or less that uses fuel cells, tidal power, solar arrays and installations, wind power installations, geothermal installations, hydroelectric generators, biomass generators, or generators fueled by municipal solid waste in conjunction with recycling. In addition to renewables, the portfolio standard can be met with "efficient resources," specifically, qualified cogeneration facilities.

Michigan

Production Incentive – Green Tag Purchase Program

Eligible Technologies: Solar Thermal Electric, Photovoltaics, Wind, Biomass, Geothermal Electric, Small Hydroelectric, Renewable Fuels

Amount: $1 to $100 per MWh total production; varies by technology and contract length

Terms: Any size system, grid tied, new renewable (January 1, 1999, or later)

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State Grant Program

Eligible Technologies: Wind, Fuel Cells, Solar, Energy Efficiency

Applicable Sectors: Commercial, Nonprofit, Schools, Local Government, State Government

Amount: Varies

Max. Limit: $6 million

Website: http://www.michigan.gov/mpsc/0,1607,7-159--102226--,00.html

The Michigan Public Service Commission (PSC) will award $6 million in funding—in the form of one or more grants—to support energy-efficiency projects, including renewable-energy technologies such as wind, solar, and fuel cells. It is anticipated that the grant(s) will be awarded

in winter 2005 to businesses, non-profit organizations, government agencies, and/or schools. The award(s) will be funded by the state's Low-Income and Energy Efficiency Fund (http://www.michigan.gov/mpsc/0,1607,7-159-16370_27289-79463--,00.html).

Generation Disclosure

Michigan's Customer Choice and Electric Reliability Act of 2000 requires electricity suppliers to disclose customer information related to the suppliers' fuel mix and emissions and requires that electric suppliers use a regional average fuel mix and emissions data when the fuel mix cannot otherwise be determined, along with the regional electric generation fuel mix, emissions and nuclear waste characteristics. All electric suppliers must disclose to customers information pertaining to the environmental characteristics of electricity production. This information must be provided twice annually and based on a rolling average.

New Hampshire

Production Incentive – Green Tag Purchase Program

Eligible Technologies: Solar Thermal Electric, Photovoltaics, Wind, Biomass, Geothermal Electric, Small Hydroelectric, Renewable Fuels

Amount: 1.7 to 6.4 cents/kWh; varies based on technology, payment plan, and contract length

Terms: Any size system, grid tied, new renewable (January 1, 1998, or later)

Website: http://www.mainstayenergy.com/

Mainstay Energy is a private company offering customers who install, or have installed, renewable energy systems the opportunity to sell the green-tag RECs associated with the energy generated by these systems. These green tags will be brought to market as Green-e (http://www.green-e.org/) certified products. Eligible technologies include solar PV, wind, biomass, geothermal electric, and hydroelectric.

Through the Mainstay Energy Rewards Program, participating customers in New England receive either quarterly production-based payments, or an up-front payment. The amount of the incentive is based on the type of renewable energy technology, the production of electricity by that system (or size, in the case of the up-front payment), and the length of the contract period. Mainstay offers 3-, 5-, and 10-year purchase contracts. The longer the contract period, the greater the incentive payment.

Net Metering

On June 25, 1998, Governor Shaheen signed into law a net-metering bill that directs all utilities selling power in New Hampshire to credit homeowners and small businesses that generate a portion of their own electricity through wind turbines, solar (photovoltaic) electric systems, or hydro power.

On January 12, 2001, the New Hampshire Public Utilities Commission approved net metering and interconnection rules for homeowners and small businesses with grid-tied renewable energy systems under 25 kW in size. The statewide limit on capacity enrolled in net metering is 0.05% of the annual peak demand of each utility. Customers generating more electricity than they use in a given billing period receive credit for the excess kWh generated.

New Mexico

Renewable Energy Production Tax Credit

Enacted in 2002, and amended in 2003 by HB 146, the New Mexico Renewable Energy Production Tax Credit provides a tax credit against the corporate income tax of 1 cent per kilowatt-hour for companies that generate electricity from wind, solar, or biomass. The credit is applicable only to the first 400,000 MWh of electricity in each of 10 consecutive years. To qualify, an energy generator must use a zero-emissions generation technology and have capacity of at least 10 MW. Energy generation from all participants combined must not exceed two million MWh of production annually. If the amount of the tax credit claimed exceeds the taxpayer's corporate income tax liability, the excess may be carried forward for up to 5 consecutive taxable years.

Production Incentive – Green Tag Purchase Program

Eligible Technologies: Solar Thermal Electric, Photovoltaics, Wind, Biomass, Geothermal Electric, Small Hydroelectric, Renewable Fuels

Amount: $1 to $100 per MWh total production; varies by technology and contract length

Terms: Any size system, grid tied, new renewable (January 1, 1999, or later)

Website: http://www.mainstayenergy.com/

Mainstay Energy is a private company offering customers who install, or have installed, renewable energy systems the opportunity to sell the green tag RECs associated with the energy generated by these systems. These green tags will be brought to market as Green-e* (http://www.green-e.org/) certified products. Through the Mainstay Energy Rewards Program, participating customers receive regular, recurring payments.

The amount of the payments depends on the type of renewable energy technology, the production of electricity by that system, and the length of the contract period. Mainstay offers 3-, 5-, and 10-year purchase contracts. The longer the contract period, the greater the incentive payment on a $/kWh basis. Payments are made quarterly.

Mandatory Utility Green Power Option

On December 17, 2002, the New Mexico Public Regulation Commission (NMPRC) unanimously approved an expansive new renewable energy rule. The rule requires investor-owned utilities and electric cooperatives to offer a voluntary renewable energy tariff (green-

pricing program) for those customers who want the option to purchase additional renewable energy. The exception is for cooperatives—they need offer this option only to the extent that their suppliers, under their all-requirements contracts, make such renewable resources available. These utilities must also develop an educational program to communicate the benefits and availability of its voluntary renewable energy program. The rule also requires public utility companies to produce 5% of all energy they generate for New Mexico customers from solar, wind, hydropower, biomass, or geothermal sources by 2006. Generation from renewables must increase by at least 1% per year until the renewable portfolio standard (RPS) of 10% is attained in the year 2011.

Net Metering

On September 30, 1999, the NMPRC issued a rule requiring all utilities regulated by the PRC (investor-owned and cooperatives) to offer net metering for cogeneration facilities and small power producers with systems of 10 kW or less. Municipal utilities are exempt because they are not regulated by the PRC. There is no statewide cap on the number of systems eligible for net metering.

Renewables Portfolio Standard

On December 17, 2002, the NMPRC unanimously approved an expansive new renewable energy rule requiring investor-owned utilities to produce 5% of all energy they generate for New Mexico customers from solar, wind, hydropower, biomass, or geothermal sources by 2006. Generation from renewable sources must increase by at least 1% per year until the RPS of 10% is attained in the year 2011. Utilities document compliance with the RPS through the use of renewable energy certificates, which represent kilowatt hours of renewable energy produced. The various sources of renewable energy have been assigned different values for the purposes of issuing certificates and calculating the percentage of electricity generated by renewables.

New York

Production Incentive – Green Tag Purchase Program

Eligible Technologies: Solar Thermal Electric, Photovoltaics, Wind, Biomass, Geothermal Electric, Small Hydroelectric, Renewable Fuels

Amount: $1 to $100 per MWh total production; varies by technology and contract length

Terms: Any size system, grid tied, new renewable (January 1, 1999, or later)

Website: http://www.mainstayenergy.com/

Mainstay Energy is a private company offering customers who install, or have installed, renewable energy systems the opportunity to sell the green-tag RECs associated with the energy generated by these systems. These green tags will be brought to market as Green-e*

(http://www.green-e.org/) certified products. Through the Mainstay Energy Rewards Program, participating customers receive regular, recurring payments.

The amount of the payments depends on the type of renewable energy technology, the production of electricity by that system, and the length of the contract period. Mainstay offers 3-, 5-, and 10-year purchase contracts. The longer the contract period, the greater the incentive payment on a $/kWh basis. Payments are made quarterly.

Solar and Wind Energy Systems Exemption

Section 487 of the New York State Real Property Tax Law provides a 15-year real property tax exemption for solar- and wind-energy systems constructed in New York State. On September 17, 2002, the property tax exemption was expanded (S.B 6592 of 2001) to include farm-waste electric-generating equipment, which is equipment that generates electric energy from biogas produced by the anaerobic digestion of agricultural waste, such as livestock manure, farming waste, and food-processing wastes with a rated capacity of not more than 400 kW. The amount of the exemption is equal to the increase in assessed value attributable to the solar, wind, or farm-waste energy system.

Generation Disclosure

On December 15, 1998, the New York Public Service Commission (PSC) issued an order requiring electric suppliers to provide information to customers regarding the environmental impacts of electricity products. The order requires suppliers to disclose fuel mix (biomass, coal, natural gas, oil, hydro, nuclear, solar, solid waste, and wind) compared to a statewide average, as well as the quantities of emissions of sulfur dioxide, nitrogen oxides, and carbon dioxide. This information must be disclosed in a standardized label twice annually. All investor-owned electric utilities and energy services companies (ESCOs) providing retail electricity, as well as those municipal or cooperative electric utilities subject to Commission jurisdiction, are required to provide the environmental disclosure label.

Green Power Purchasing

New York state buildings and vehicles (including those of quasi-independent agencies like the State University of New York and the Metropolitan Transportation Authority) using solar thermal electric, PV, landfill gas, wind, biomass, geothermal electric, fuel cells, other methane waste, and tidal energy.

Net Metering

Eligible Technologies: PV, Wind, Biomass

Limit on System Size: 10 kW (solar); 400 kW (farm-waste electric-generating equipment); 25 kW (residential wind); 125 kW (farm-based wind)

Limit on Overall Enrollment: 0.1% of 1996 demand per IOU (solar); 0.4% of demand per IOU (farm systems)

Treatment of Net Excess: Credited monthly at avoided cost, except for residential wind generation, which is credited monthly at retail rate. Accounts reconciled annually at avoided cost.

Utilities Involved: All utilities

Interconnection Standards for Net Metering? Yes

Website: http://www.dps.state.ny.us/distgen.htm

Wind Law Expiration Date: December 31, 2008

Systems Benefits Charge

Eligible Technologies: Solar Thermal Electric, Photovoltaics, Wind, Biomass, Hydroelectric, Renewable Transportation Fuels, Geothermal Electric, Fuel Cells, Cogeneration

Applicable Sectors: General Public/Consumer

Types: Energy efficiency, R&D (includes renewables), low-income programs

Total Fund: 8-year budget is $210.8 million for R&D (includes renewables)

Charge: 0.6 mill/kWh

Website: http://www.nyserda.org/rddopps.html

Renewables Portfolio Standard

The New York PSC adopted an RPS in an Order issued and effective September 24, 2004. The RPS seeks to increase the amount of electricity available to consumers in New York that is generated from renewable resources to at least 25% by the end of 2013. After that, energy will be procured from additional resources through central procurement to commence early in 2006 and through continuation of voluntary efforts by green marketers in the State's competitive retail markets.

The RPS requires that the state's investor-owned utilities collect revenues from their delivery customers to fund the central procurement program, with the exception of those customers exempt from contributing to the State's Systems Benefits Charge (http://www.dsireusa.org/library/includes/incentive2.cfm?Incentive_Code=NY07R&state=NY&CurrentPageID=1) program.

Municipal-owned utilities, the New York Power Authority, and the Long Island Power Authority do not fall under the jurisdiction of this program, but are encouraged to adopt similar programs. Approximately 19% of the electricity consumed in New York is from renewable sources—most

of this generation from large-scale hydroelectric facilities—so the RPS target will require an additional 3,700 MW of renewable resource generation capacity.

Nevada

Production Incentives

Green Tag Purchase Program

Eligible Technologies: Solar Thermal Electric, Photovoltaics, Wind, Biomass, Geothermal Electric, Small Hydroelectric, Renewable Fuels

Amount: $1 to $100 per MWh total production; varies by technology and contract length

Terms: Any size system, grid tied, new renewable (January 1, 1999, or later)

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Renewable Energy Credits

Nevada's Renewable Energy Portfolio Standard requires the state's two investor-owned utilities to derive a minimum percentage of the electricity they sell from renewable energy resources. Included in the standard is a REC program. The PUC is in the process of drafting the permanent regulations for RECs. Starting January 1, 2003, Nevada's renewable energy producers can earn RECs, which can then be sold to utilities that are required to meet Nevada's portfolio standard.

One REC will represent a kilowatt-hour of electricity generated from a renewable energy system, with the exception of PV, which counts as 2.4 kWh per AB 296 of 2003. The value of a REC is market-driven. RECs are issued by Nevada’s PUC and are valid for 5 years.

Renewable energy is defined as biomass, geothermal energy, solar energy, wind, and waterpower. Solar energy includes any displacement of fossil energy use and could include (solar daylighting, solar water heating, etc.)

Renewable Energy Producers Property Tax Exemption

Enacted by SB 227 on June 1, 2001, this statute allows certain new or expanded businesses a 50% property tax exemption for real and personal property used to generate electricity from renewable energy. The exemption may be taken over a 10-year period by a business that uses renewable energy as its primary source of energy and that has a generating capacity of at least 10 kW. Renewable energy includes biomass, solar, and wind.

Renewable Energy Systems Exemption

This statute states that any value added by a qualified renewable energy source shall be subtracted from the assessed value of any residential, commercial, or industrial building for property tax purposes. Qualified equipment includes solar, wind, geothermal, solid waste, and hydro. This exemption applies for all years following installation.

Renewable Energy/Solar Sales Tax Exemption

The sales/use tax rate for any sales, storage, consumption, or use of products or systems designed or adapted to use renewable energy to generate electricity and all of its integral components is 2% in all counties for those purchases made from January 1, 2002, through June 30, 2005.

Renewable energy means a source of energy that occurs naturally or is regenerated naturally, including without limitation biomass, fuel cells, geothermal energy, solar energy, waterpower, and wind. Biomass includes agricultural crops, wastes, and residues; wood, wood wastes, and residues; animal wastes; municipal wastes; and aquatic plants. SB 489 of 2003 extended this exemption to solar water heating and solar lighting systems, as well as extending the expiration date to July 1, 2005. Systems designed or adapted to use renewable energy to generate electricity means a system of related components from which at least 75% of the electricity generated is produced from one or more sources of renewable energy and that is designed to work as an integral package such that the system is not complete without one of its related components.

Generation Disclosure

Beginning January 2002, each electric utility must disclose certain information to its customers, according to regulations established by the Nevada PUC. The disclosure must be in a standard format, provided in bill inserts twice a year, as well as on utility web sites. The disclosure must include the average mix of fuel sources used to create electricity, average emissions, customer service information, and information on low-income energy programs.

Net Metering

In 1997, Nevada enacted a law allowing investor-owned utility customers who generate up to 10 kW of solar or wind power to net meter. In 2001, AB 661 removed the limit on the amount of energy a utility can receive through net metering. In 2003, AB 429 increased the limit on system size from 10 kW to 30 kW and added waterpower (restricted to certain types) to the definition of renewable energy, which already includes biomass, geothermal energy, solar energy, and wind.

Also in 2003, per AB 296, in complying with a portfolio standard, each 1 kWh of electricity generated from solar photovoltaics counts as 2.4 kWh, if the electricity is generated on the premises of a retail customer who uses at least 50% of the electricity.

Customer generators are billed monthly except in situations in which the customer and the utility agree on annual billing. Net excess generation is credited to the utility and is considered renewable energy that the utility has generated to fulfill its renewable energy portfolio. Utilities are required to supply a two-way meter to measure flow in both directions, and utilities are prohibited from adding any additional charges to the bills of those customers participating in net metering. Furthermore, utilities cannot place any additional standards or requirements on customer generators beyond those requirements established by the National Electric Code (NEC), Underwriters Laboratories (UL), and the Institute of Electrical and Electronic Engineers (IEEE).

Renewables Portfolio Standard

As part of its 1997 restructuring legislation, the Nevada legislature established an RPS. Under the standard, the state's two investor-owned utilities, Nevada Power and Sierra Pacific Power, must derive a minimum percentage of the total electricity they sell from renewable energy resources. In 2001, the legislature revised the minimum amounts to increase by 2% every 2 years, starting with a 5% renewable energy requirement in 2003 and achieving a 15% requirement by 2013 and each year thereafter. Not less than 5% of the renewable energy must be generated from solar renewable energy systems.

North Carolina

Production Incentives

Green Tag Purchase Program

Eligible Technologies: Solar Thermal Electric, Photovoltaics, Wind, Biomass, Geothermal Electric, Small Hydroelectric, Renewable Fuels

Amount: $1 to $100 per MWh total production; varies by technology and contract length

Terms: Any size system, grid tied, new renewable (January 1, 1999, or later)

Website: http://www.mainstayenergy.com/

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5-, and 10-year purchase contracts. The longer the contract period, the greater the incentive payment on a $/kWh basis. Payments are made quarterly.

TVA – Green Power Switch Generation Partners Program

Eligible Technologies: PV, Wind

Amount: $500 (residential only) plus $0.15 per kWh for 10 years (residential and commercial)

Terms: $500 payment available until the program capacity reaches 150 kW

Website: http://www.gpsgenpartners.com

TVA and participating power distributors currently offer a dual-metering option to residential and small-commercial consumers (non-demand-metered) through the Green Power Switch Generation Partners program. The output (green power) generated from this program will be counted as a TVA Green Power Switch resource.

Through this program, TVA will purchase the entire output of a qualifying system at $0.15 per kWh through a participating power distributor, and the consumer will receive a credit for the power generated. Participation in this program is entirely up to the discretion of the power distributor. As of June 2004, about a dozen distributors have signed up for the program. Thus far, the program includes several residential solar participants and one 20-kW wind project.

Energy Improvement Loan Program

The Energy Improvement Loan Program (EILP) is available to North Carolina businesses, local governments, public schools, and nonprofit organizations that demonstrate energy efficiency, use of renewable energy resources, energy cost savings, or reduced energy demand. Loans with an interest rate of 1% to a maximum limit of $500K are available for certain renewable energy and energy recycling projects. Eligible renewable energy projects generally include solar, wind, small hydro (less than 20 MW), and biomass. A rate of 3% is available for projects that demonstrate energy efficiency, energy cost-savings, or reduced energy demand. In order to qualify for an EILP low-interest loan, a project must (1) be located in North Carolina; (2) demonstrate energy efficiency, use of renewable energy resources, or result in energy cost savings; (3) use existing reliable, commercially available technologies; (4) meet federal and state air and water quality standards; and (5) be able to recover capital costs within the loan's maximum term of 10 years through energy cost savings.

North Dakota

Production Incentive – Green Tag Purchase Program

Eligible Technologies: Solar Thermal Electric, Photovoltaics, Wind, Biomass, Geothermal Electric, Small Hydroelectric, Renewable Fuels

Amount: $1 to $100 per MWh total production; varies by technology and contract length

Terms: Any size system, grid tied, new renewable (January 1, 1999, or later)

Website: http://www.mainstayenergy.com/

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The amount of the payments depends on the type of renewable energy technology, the production of electricity by that system, and the length of the contract period. Mainstay offers 3-, 5-, and 10-year purchase contracts. The longer the contract period, the greater the incentive payment on a $/kWh basis. Payments are made quarterly.

Large Wind Property Tax Reduction

North Dakota modified its property tax incentives for large wind systems with its 2001 bill that reduces property taxes by 70% for wind facilities of 100 kW or larger. To be eligible, construction must begin by January 1, 2011. The state also has a sales tax exemption for these systems.

Geothermal, Solar, and Wind Property Tax Exemption

North Dakota exempts from local property taxes any solar, wind, or geothermal energy device. Qualifying systems can be stand alone or part of a conventional system, but in the case where the solar, wind, or geothermal system is part of a conventional energy system, only the renewable energy portion of the total system is eligible. This exemption is applied only during the 5-year period following installation. To apply for this exemption, system owners must contact their local tax assessor or their county director of tax equalization.

Large Wind Sales Tax Exemption

North Dakota's large wind sales tax exemption applies to the owner of a wind-powered electrical generating facility that has at least one single electrical energy generation unit with a nameplate capacity of 100 kW or more. The exemption will apply to building materials, production equipment, and other tangible personal property used in the construction of the facility. The exemption applies to any sales or use tax that would be due in the construction of the facility between July 2001 and January 2011.

Net Metering

Passed in 1991 by the North Dakota PUC, this net-metering ruling applies to both renewable energy generators and cogenerators up to 100 kW in capacity. Net metering is available to all customer classes, and there is no statewide limit to the capacity signed up for net metering. When customers have excess generation in a monthly billing period, utilities must purchase net excess generation at the avoided cost.

Oklahoma

Zero-Emission Facilities Production Tax Credit

Starting January 1, 2003, an income tax credit is available to producers of electric power using renewable energy resources from a zero-emission facility located in Oklahoma. The zero-emission facility must have a rated production capacity of 50 MW or more. Renewable energy resources include wind, moving water, sun, and geothermal energy. The construction and operation of the zero-emission facility must result in no pollution or emissions that are or may be harmful to the environment, as determined by the Department of Environmental Quality.

The amount of the credit varies depending on when the electricity is generated. For electricity generated after January 1, 2004, but prior to January 1, 2007, the amount of the credit is $0.005 per kilowatt-hour for electricity generated by zero-emission facilities. For electricity generated after January 1, 2007, but prior to January 1, 2012, the amount of the credit is $0.0025 per kilowatt-hour of electricity generated by zero-emission facilities.

Credits may be claimed over a 10-year period, and non-taxable entities may transfer the tax credit to taxable entities.

Production Incentive – Green Tag Purchase Program

Eligible Technologies: Solar Thermal Electric, Photovoltaics, Wind, Biomass, Geothermal Electric, Small Hydroelectric, Renewable Fuels

Amount: $1 to $100 per MWh total production; varies by technology and contract length

Terms: Any size system, grid tied, new renewable (January 1, 1999, or later)

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The amount of the payments depends on the type of renewable energy technology, the production of electricity by that system, and the length of the contract period. Mainstay offers 3-, 5-, and 10-year purchase contracts. The longer the contract period, the greater the incentive payment on a $/kWh basis. Payments are made quarterly.

Net Metering

Net metering has been available in Oklahoma since 1988 under Oklahoma Corporate Commission Order 326195. This ruling requires investor-owned utilities and rural cooperatives under the Commission's jurisdiction to file net-metering tariffs for customer-owned renewable

energy and cogeneration facilities at 100 kW or less in capacity. The program is available to all customer classes, and there is no statewide limit to the amount of net-metering capacity.

Utilities are not allowed to impose extra charges for customers signed up for net metering, nor are they allowed to require new liability insurance as a condition for interconnection. Utilities are also not required to purchase net excess generation from customers. The ruling, however, does allow customers to request that utilities purchase the net generation. In this case, the utility purchases the generation at the utility's filed avoided cost. Although all renewable energy sources are eligible, only wind-generating systems have used net metering in Oklahoma to date. In most cases, customer generation does not exceed demand.

Oregon

Business Energy Tax Credit

Eligible Technologies: Passive Solar Space Heat, Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Photovoltaics, Wind, Biomass, Hydroelectric, Renewable Transportation Fuels, Geothermal Electric, Geothermal Heat Pumps, Municipal Solid Waste, Cogeneration, Hydrogen, Refueling Stations, Ethanol, Methanol, Biodiesel, Fuel Cells (Renewable Fuels), Energy Efficiency

Amount: 35% of project costs

Max. Limit: $10,000,000 per project

Terms: Distributed over 5 years; 8-year carry forward

Website: http://www.energy.state.or.us/bus/tax/taxcdt.htm

Renewable Energy Grant

Using revenues generated from the sales of Green Tags, Bonneville Environmental Foundation (BEF), a not-for-profit organization, accepts proposals for funding for renewable energy projects located in the Pacific Northwest (Oregon, Washington, Idaho, Montana). Any private person, organization, local or tribal government located in the Pacific Northwest may participate. Projects that generate electricity are preferred. Acceptable projects include solar PV, solar thermal electric, solar hot water, wind, hydro, biomass, and animal waste-to-energy.

BEF may deliver funding through various means, including grants, loans, convertible loans, guarantees, and direct investments in renewable energy projects. BEF renewable-energy grants and investments may range from a few thousand dollars for small installations, to significant investments in central station grid-connected renewable energy projects. If a BEF grant is requested for a generating project, the BEF share will not exceed 33% of total capital costs and 0% of operating costs.

Production Incentives

Solar Starters

The Bonneville Environmental Foundation (BEF) and the Northwest Solar Cooperative have joined together to help reduce the costs of small residential and commercial photovoltaic systems in parts of Oregon and Washington; systems up to 5 kW are approved automatically; larger sizes may be acceptable. The Northwest Solar Cooperative will sign 5-year agreements with the owners of new photovoltaic systems and will pay them an annual amount equivalent to 10¢/kWh for the environmental attributes—or Green Tags—produced by the solar systems. System owners will be paid annually. BEF will then purchase the Green Tags from the Northwest Solar Cooperative and sell them to its wholesale customers and on its web site (https://www.greentagsusa.org/GreenTags/index.cfm). The first phase of the project is projected to include 30 to 50 small photovoltaic systems. There are 36 participants in the program.

Green Tag Purchase Program

Eligible Technologies: Solar Thermal Electric, Photovoltaics, Wind, Biomass, Geothermal Electric, Small Hydroelectric, Renewable Fuels

Amount: $1 to $100 per MWh total production; varies by technology and contract length

Terms: Any size system, grid tied, new renewable (January 1, 1999, or later)

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The amount of the payments depends on the type of renewable energy technology, the production of electricity by that system, and the length of the contract period. Mainstay offers 3-, 5-, and 10-year purchase contracts. The longer the contract period, the greater the incentive payment on a $/kWh basis. Payments are made quarterly.

New Renewable Energy Resources Grants

This program is designed to support renewable energy projects that do not already have an established incentive program developed and launched by the Energy Trust of Oregon. They expect to reserve 10% of the Renewable Energy program budget, which is about $1 million annually, for open solicitation incentives. Projects will generally be awarded in the areas of small wind, solar PV, biomass, biogas, small hydro, and geothermal electric.

Small Scale Energy Loan Program (SELP)

Eligible Technologies: Passive Solar Space Heat, Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Photovoltaics, Wind, Biomass, Hydroelectric, Renewable Transportation Fuels, Geothermal Electric, Municipal Solid Waste, Cogeneration, Waste Heat Recovery

Applicable Sectors: Commercial, Industrial, Residential, Nonprofit, Schools, Local Government, State Government, Tribal Government, Rural Electric Cooperative

Amount: Typically $20,000 to $20 million

Max. Limit: None

Terms: Repayment to match term of bonds

Website: http://www.energy.state.or.us/loan/selphme.htm

Generation Disclosure

Under Oregon's 1999 electric utility restructuring legislation, electricity suppliers are required to disclose their fuel mix and emissions. Beginning March 1, 2002, disclosure must be supplied using a format prescribed by the Oregon PUC. Power source and environmental impact information must be provided to all residential consumers at least quarterly.

Green Power Purchasing

Portland: municipal buildings using PV, wind, biomass, geothermal electric, and anaerobic digestion

Net Metering

Oregon's net metering law, HB 3219 of July 1999, allows net metering for customers with solar, wind, or hydropower systems up to 25 kW. All customer classes are eligible, but enrollment is limited to a total installed capacity of 0.5% of a utility's historic single-hour peak load. Above this installed capacity, net-metering eligibility can be limited by regulatory authority. Net excess generation is either purchased at avoided cost or credited to the customer's next monthly bill. At the end of an annual period, any unused credit is granted to the electric utility. This credit is then either granted to customers enrolled in the utility's low-income assistance programs, credited to the generating customer, or "dedicated to other use."

In 1996, the City of Ashland enacted a net-metering law establishing a simple grid interconnection policy. It encourages the adoption of solar energy systems by allowing net metering and committing the City to purchase, at full retail price, up to 1,000 kWhs of excess electricity per month from small wind or solar energy systems.

Public Benefits Fund

Eligible Technologies: Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Photovoltaics, Wind, Biomass, Hydroelectric, Geothermal Electric, Direct-Use Geothermal Energy, Fuel Cells (Renewable Fuels)

Types: Renewables, Efficiency, Low Income, Schools

Total Fund: $10 million for renewables/year

Charge: 3% paid by certain electricity users

Website: http://www.energytrust.org/Frames/Frameset.html?mainFrame=http%3A//www.energytrust.org/Pages/renewable_energy_programs/index.html

South Dakota

Production Incentive – Green Tag Purchase Program

Eligible Technologies: Solar Thermal Electric, Photovoltaics, Wind, Biomass, Geothermal Electric, Small Hydroelectric, Renewable Fuels

Amount: $1-$100 per MWh total production; varies by technology and contract length

Terms: Any size system, grid tied, new renewable (January 1, 1999, or later)

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Wind Energy Property Tax Exemption

This wind energy property tax exemption bill requires that all commercial wind-power production facilities, regardless of ownership, now be assessed at the local level. Previously, some facilities were centrally assessed for tax purposes at the state level. The assessment is for the base, foundation, tower, and substations, which are considered real property. It doesn't include the generator and turbine blades, which are considered personal property.

Tennessee

Production Incentives - Green Tag Purchase Program

Eligible Technologies: Solar Thermal Electric, Photovoltaics, Wind, Biomass, Geothermal Electric, Small Hydroelectric, Renewable Fuels

Amount: $1 to $100 per MWh total production; varies by technology and contract length

Terms: Any size system, grid tied, new renewable (January 1, 1999, or later)

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TVA – Green Power Switch Generation Partners Program

Eligible Technologies: Photovoltaics, Wind

Amount: $500 (residential only) plus $0.15 per kWh for 10 years (residential and commercial)

Terms: $500 payment available until the program capacity reaches 150 kW

Website: http://www.gpsgenpartners.com

TVA and participating power distributors currently offer a dual-metering option to residential and small-commercial consumers (non-demand-metered) through the Green Power Switch Generation Partners program. The output (green power) generated from this program will be counted as a TVA Green Power Switch resource. Through this program, TVA will purchase the entire output of a qualifying system at $0.15 per kWh through a participating power distributor, and the consumer will receive a credit for the power generated. Participation in this program is entirely up to the discretion of the power distributor. As of June 2004, about a dozen distributors have signed up for the program. Thus far, the program includes several residential solar participants and one 20-kW wind project.

Wind Energy Systems Tax Exemption

Tennessee House Bill 809, passed in June 2003, states that wind-energy systems operated by public utilities, businesses, or industrial facilities shall not be taxed at more than one-third of their total installed cost. This law applies to the initial appraisal and subsequent appraisals of wind-energy systems.

Texas

Hansford County Tax Abatement

On November 12, 2002, the Hansford County, Texas Commissioners created a tax abatement agreement with Great Plains Windpower, L.L.C. The agreement authorized tax abatements (an exemption from ad valorem taxes on property) in a Reinvestment Zone located in Hansford County.

Improvements eligible for Abatement under the agreement include real property and personal property comprising the wind-energy facilities within the Reinvestment Zones, including (i) the wind-turbine generators, (ii) electric substations and related components, (iii) power collection system electric cable and electric power transmission lines, (iv) foundations and support structures, (v) communication and other wiring and lines, (vi) wind measurement towers, (vii) roads and fences, (viii) spare parts and equipment, and (ix) other physical assets and improvements.

The Abatement amount is 95% in the first through third years. The fourth and fifth years the abatement is 90%. In the sixth and seventh years the abatement is 70%. No abatement will be provided starting with the eighth year.

Production Incentive – Green Tag Purchase Program

Eligible Technologies: Solar Thermal Electric, Photovoltaics, Wind, Biomass, Geothermal Electric, Small Hydroelectric, Renewable Fuels

Amount: $1 to $100 per MWh total production; varies by technology and contract length

Terms: Any size system, grid tied, new renewable (January 1, 1999, or later)

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5-, and 10-year purchase contracts. The longer the contract period, the greater the incentive payment on a $/kWh basis. Payments are made quarterly.

Generation Disclosure

As part of its 1999 electric utility restructuring legislation, Texas retail electric providers (REP) are required to disclose certain information to customers on an Electricity Facts Label. Beginning July 1, 2002, REPs must provide the standardized format Electricity Facts Label to customers upon their request. The Label must include electricity prices, contract terms, sources of generation, and emissions levels. This information can help customers choose who they want to provide their electric service.

Net Metering

Texas's net-metering rule (i.e., arrangements Between Qualifying Facilities and Electric Utilities § 25.242[h][4]) was established by the Texas PUC to promote small wind power and photovoltaic generation in the state. The order requires certain utilities to offer a net-metering option to qualified facilities of 50 kW or less that use renewable resources. The rule applies to all Texas price-to-beat retail electric providers (PTB REPs), transmission and distribution utilities (TDUs), and integrated investor-owned utilities that have not unbundled in accordance with Public Utility Regulatory Act § 39.051.

This rule does not apply to municipal utilities, river authorities, or electric cooperatives. For customers of qualifying utilities, the utility must install a single meter that can read electric flow in both directions. There is no statewide limit on the number of customers or total capacity under the net metering program. Net consumption is billed at the applicable tariff and excess generation by the customers during a billing cycle is purchased by utilities at rates not to exceed the avoided cost (fuel cost only, no capacity component).

San Antonio and Austin have their own net metering rules.

Renewables Portfolio Standard

On December 16, 1999, the Texas PUC issued the Renewable Energy Mandate Rule. This standard establishes the state's renewable portfolio standard, a renewable energy credits trading program (trading program), and defines the renewable energy purchase requirements for competitive retailers in Texas. The standard calls for 2,000 MW of new renewables to be installed in Texas by 2009, which is in addition to the 880 MW of existing renewables generation. The rule also (1) implements the statutory mandate in PURA §39.904 to promote the development of renewable energy technologies, (2) encourages the construction and operation of new renewable-energy projects at Texas sites having the greatest potential for development, (3) reduces air pollution in Texas from fossil-fuel electric generation, (4) responds to customer preferences for more "clean" energy from renewable resources, (5) increases the amount of renewable energy available in Texas, and (6) ensures that customers have access to energy from renewable energy resources pursuant to PURA §39.101(b)(3). The standard is 400 MW by 2002, increasing to 2,000 by 2009 (and maintained to 2019).

Qualifying renewable energy sources include solar, wind, geothermal, hydroelectric, wave or tidal energy, or biomass or biomass-based waste products, including landfill gas. Qualifying systems are those installed after September 1999. The RPS applies to all retail energy providers including municipal and cooperative utilities.

Austin Energy has its own renewables portfolio standard.

Utah

Production Incentive – Green Tag Purchase Program

Eligible Technologies: Solar Thermal Electric, Photovoltaics, Wind, Biomass, Geothermal Electric, Small Hydroelectric, Renewable Fuels

Amount: $1 to $100 per MWh total production; varies by technology and contract length

Terms: Any size system, grid tied, new renewable (January 1, 1999, or later)

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The amount of the payments depends on the type of renewable energy technology, the production of electricity by that system, and the length of the contract period. Mainstay offers 3-, 5-, and 10-year purchase contracts. The longer the contract period, the greater the incentive payment on a $/kWh basis. Payments are made quarterly.

Green Power Purchasing

Salt Lake City – local government buildings using wind

Net Metering

On March 15, 2002, Governor Leavitt signed into law House Bill 7, Net Metering of Electricity. This law requires all electric utilities and cooperatives in Utah (municipal utilities are excluded) to allow customers to connect renewable energy systems to the grid for their own use and to supply excess electricity to the electric grid. Eligible renewable energy systems include fuel cells, solar, wind, or small hydropower facilities with a generating capacity of up to 25 kilowatts. Total participation in the program is capped at 0.1% of the cumulative generating capacity of the electrical corporation's peak demand during 2001.

Utilities are required to give the customer a credit for electricity generated that exceeds the amount supplied. If net metering results in excess customer-generated electricity during the

billing period, the utility must credit the customer for the excess customer-generated electricity at a value that is at least avoided cost. All credits that the customer does not use during the calendar year expire at the end of the calendar year.

Vermont

Production Incentive – Green Tag Purchase Program

Eligible Technologies: Solar Thermal Electric, Photovoltaics, Wind, Biomass, Geothermal Electric, Small Hydroelectric, Renewable Fuels

Amount: 1.7 to 6.4 cents/kWh; varies based on technology, payment plan, and contract length

Terms: Any size system, grid tied, new renewable (January 1, 1998, or later)

Website: http://www.mainstayenergy.com/

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Through the Mainstay Energy Rewards Program, participating customers in New England receive either quarterly production-based payments or an up-front payment. The amount of the incentive is based on the type of renewable energy technology, the production of electricity by that system (or size, in the case of the up-front payment), and the length of the contract period. Mainstay offers 3-, 5-, and 10-year purchase contracts. The longer the contract period, the greater the incentive payment. Payments are made quarterly.

Generation Disclosure

In 2002, Vermont's Governor signed into law a bill (S.138) authorizing the Vermont Public Service Board (PSB) to prescribe standards for electricity suppliers to disclose information on fuel sources and the environmental impacts of electricity generation. This information would be provided to retail customers on an annual or less-frequent basis.

The disclosure standards may address the form of the labels and information related to retail and wholesale price, terms and conditions of service, the fraction of generation resources in a seller's mix, the environmental effects of each energy source, and a description of other services, such as energy efficiency opportunities.

Net Metering

Vermont's net metering law caps the size of net metering generators at 15 kilowatts AC capacity for certain renewable forms of energy generation, such as photovoltaic systems, wind turbines, and fuel cells (when fueled by renewable sources). Excess generation during a billing period will

be credited to the next billing period until the end of the calendar year. At the beginning of the next calendar year, any remaining credited will be granted to the utility without compensation to the customer.

In addition, a new class of net-metering system, the farm system, was established. Farmers who generate electricity from anaerobic digestion of agricultural products, byproducts, or from PV, wind, or fuel cells, can net meter systems of up to 150 kilowatts.

Washington

Renewable Energy Grant

Using revenues generated from the sales of Green Tags, Bonneville Environmental Foundation (BEF), a not-for-profit organization, accepts proposals for funding for renewable energy projects located in the Pacific Northwest (Oregon, Washington, Idaho, Montana). Any private person, organization, local or tribal government located in the Pacific Northwest may participate. Projects that generate electricity are preferred. Acceptable projects include solar PV, solar thermal electric, solar hot water, wind, hydro, biomass, and animal waste-to-energy.

BEF may deliver funding through various means, including grants, loans, convertible loans, guarantees, and direct investments in renewable energy projects. BEF renewable energy grants and investments may range from a few thousand dollars for small installations, to significant investments in central station grid-connected renewable energy projects. If a BEF grant is requested for a generating project, the BEF share will not exceed 33% of total capital costs and 0% of operating costs.

Production Incentives

Solar Starters

The BEF and the Northwest Solar Cooperative have joined together to help reduce the costs of small residential and commercial PV systems in parts of Oregon and Washington, small systems of 5 kW are approved automatically; larger sizes may be acceptable). The Northwest Solar Cooperative will sign 5-year agreements with the owners of new photovoltaic systems and will pay them an annual amount equivalent to 10¢/kWh for the environmental attributes (Green Tags) produced by the solar systems. System owners will be paid annually. BEF will then purchase the Green Tags from the Northwest Solar Cooperative and sell them to its wholesale customers and on its web site, https://www.greentagsusa.org/GreenTags/index.cfm. The first phase of the project is projected to include 30 to 50 small photovoltaic systems. There are currently 36 participants in the program.

Green Tag Purchase Program

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Sales and Use Tax Exemption

On May 8, 2001, the Governor of Washington signed legislation, H.B. 1859, expanding the sales and use tax exemption for solar, wind, and landfill gas electric generating facilities to include fuel cells. In addition, the exemption now applies to smaller systems, those that have a generating capacity of at least 200 watts.

Generation Disclosure

Washington is one of several states that requires disclosure even though its electricity market has not been restructured. Beginning in May 2001, retail electricity suppliers in Washington must provide a disclosure label in a standard format to their retail customers at least semiannually. The disclosure label must be provided to new customers at the time service is established. Existing customers should receive the disclosure label as a bill insert or mailed publication. Small utilities and mutual light and power companies must provide the disclosure label annually unless they market a "specific electric product new to that utility."

Green Power Purchasing

Clark County – local government buildings using PV and wind

Seattle – local government buildings using wind

Mandatory Utility Green Power Option

On May 8, 2001, the Governor of Washington signed EHB 2247, which requires each electric utility (this includes investor owned utilities and consumer owned utilities) to offer customers the option to purchase power generated from renewable sources—defined as produced by wind, solar, geothermal, landfill gas, wave or tidal action, wastewater treatment gas, some biomass and "qualified hydropower" that is fish-friendly.

Net Metering

Washington's net-metering law, enacted March 1998 (HB 2773), allows net metering for customers with solar, wind, and hydropower systems of 25 kW or less that are intended primarily to offset part or all of the customer's requirements for electricity. Then in 2000, EH 2334, added fuel cells as another type of eligible system. All customer classes are eligible for enrollment. Enrollment is limited to a statewide installed generating capacity of 0.1% of the utility's 1996 peak demand.

Grays Harbor PUD has established its own net-metering rules.

West Virginia

Tax Exemption for Wind Energy Generation

West Virginia passed legislation in May 2001 lowering the Business and Operation Tax (B&O) on utilities using wind-power generation. For most types of electricity-generating units, the B&O tax is 40% of the generating capacity of the unit. However, the B&O tax on a wind turbine is 5% of the generating capacity of the turbine.

Production Incentive – Green Tag Purchase Program

Eligible Technologies: Solar Thermal Electric, Photovoltaics, Wind, Biomass, Geothermal Electric, Small Hydroelectric, Renewable Fuels

Amount: 1.7 to 6.4 cents/kWh; varies based on technology, payment plan, and contract length

Terms: Any size system, grid tied, new renewable (January 1, 1998, or later)

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Through the Mainstay Energy Rewards Program, participating customers in New England receive either quarterly production-based payments, or an up-front payment. The amount of the incentive is based on the type of renewable energy technology, the production of electricity by that system (or size, in the case of the up-front payment), and the length of the contract period. Mainstay offers 3-, 5-, and 10-year purchase contracts. The longer the contract period, the greater the incentive payment. Payments are made quarterly.

Special Assessment for Wind Energy Systems

West Virginia enacted legislation in May 2001 lowering the property tax on utility-owned wind turbines from 100% to 5% of assessed value. This change took effect in July 2001.

Wyoming

Production Incentive – Green Tag Purchase Program

Eligible Technologies: Solar Thermal Electric, Photovoltaics, Wind, Biomass, Geothermal Electric, Small Hydroelectric, Renewable Fuels

Amount: 1.7 to 6.4 cents/kWh; varies based on technology, payment plan, and contract length

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Net Metering

House Bill 195 was passed by the House and Senate of the Wyoming legislature and signed by the Governor on February 22, 2001. As a result, net metering took effect July 1, 2001. The rule applies to investor-owned utilities and rural electric cooperatives and, with the passage of Senate File 106 in 2003, to municipal utilities. Eligible technologies under the 2001 legislation include solar, wind, and hydropower systems up to 25 kW, with the addition of biomass in 2003.

Excess generation is credited to the following month. When an annual period ends, the utility purchases unused credits at avoided cost.

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USFS, DOE, and NREL

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REPORT DOCUMENTATION PAGE

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13. SUPPLEMENTARY NOTES

14. ABSTRACT *(Maximum 200 Words)*

This technical report and CD for the U.S. Department of Agriculture, Forest Service (USFS), evaluates the potential for renewable energy resource development on National Forest System (NFS) lands. USFS can use the report findings to consider potential for development of solar and wind energy resources on NFS lands, in land management decisions. The Geographical Information System (GIS) based analysis resulted in the following findings: (1) Ninety-nine National Forest Units have high potential for power production from one or more of these solar and wind energy sources; and (2) Twenty National Forest Units in nine states have high potential for power production from two or more of these solar and wind energy sources.

15. SUBJECT TERMS
wind energy; solar energy; photovoltaics; PV; concentrating solar power; CSP; National Forest; National Forest System; National Forest lands; renewable resources; renewable resource potential; USDA; Forest Service

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