Cedar City Field Office Resource Management Plan/Environmental Impact Statement:

Analysis of the Management Situation

Appendix K

Renewable Resources Report

BLM

Renewable Energy Potential Report

Cedar City Field Office

Resource Management Plan/Environmental Impact Statement

June, 2011

U.S. DEPARTMENT OF THE INTERIOR BUREAU OF LAND MANAGEMENT
NATIONAL SYSTEM OF PUBLIC LANDS

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Renewable Energy Potential Report

CEDAR CITY FIELD OFFICE

RESOURCE MANAGEMENT PLAN/ENVIRONMENTAL IMPACT STATEMENT

United States Department of the Interior

Bureau of Land Management

Cedar City Field Office, Utah

June 2011

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Acronyms and Abbreviations

ACEC	Areas of Critical Environmental Concern
AGRC	Automated Geographic Reference Center
AMS	Analysis of the Management Situation
BDT	Bone Dry Tons
BLM	Bureau of Land Management
BMP	Best Management Practice
CCFO	Cedar City Field Office
CROP	Coordinated Resource Offering Protocol
CSA	Candidate Study Area
CSP	Concentrating Solar Power
DNI	Direct Normal Insolation
DOD	Department of Defense
DOE	Department of Energy
DOI	Department of the Interior
EIS	Environmental Impact Statement
EO	Executive Order
FIA	Forest Inventory and Analysis
FFO	Fillmore Field Office
GIS	Geographic Information System
IM	Instruction Memorandum
IR	Indian Reservation
$KWh/m^2/day$	Kilowatt-Hours Per Square Meter Per Day
MFP	Management Framework Plan
MW	Megawatts
NEPA	National Environmental Policy Act
NPS	National Park Service
NREL	National Renewable Energy Laboratory
NSO	No Surface Occupancy
NWSEED	Northwest Sustainable Energy for Economic Development
OHV	Off-Highway Vehicle
PEIS	Programmatic Environmental Impact Statement
POD	Plan of Development
PV	Photovoltaic
QRA	Qualified Resource Area
REZ	Renewable Energy Zone

RFDS	Reasonably Foreseeable Development Scenario
RMP	Resource Management Plan
ROD	Record of Decision
ROW	Right of Way
TPA	Tons Per Acre
UGS	Utah Geological Survey
UREZ	Utah Renewable Energy Zone
USDA	U. S. Department of Agriculture
USFS	U.S. Forest Service
WREZ	Western Renewable Energy Zones

EXECUTIVE SUMMARY

ES.1 Introduction

The planning area for the Bureau of Land Management (BLM) Cedar City Field Office (CCFO) Resource Management Plan (RMP) is one of several focus areas of current and future renewable energy development in the state of Utah. The focus of development includes wind, solar, geothermal, and biomass resources that can be converted to electrical power at a commercial utility scale. Within the planning area, there are currently three operating geothermal power plants and more than 8,000 acres of geothermal leases. One wind energy project is operational and more than 160,000 acres are under project right of way (ROW) applications, for both meteorological testing and project development. Three Solar Energy Zones totaling 19,191 acres are currently being evaluated in the Draft Programmatic EIS (PEIS) for Solar Energy Development. Expansion of the existing geothermal projects and the existing wind project is already in the planning or permitting stages. The planning area is also the location of major existing and planned interstate transmission lines and corridors, a key factor for the economic viability of such power generation projects. It is in this context that the CCFO is updating its RMP and preparing an accompanying Environmental Impact Statement (EIS). In support of that effort, the CCFO initiated the assessment of the potential for renewable energy resource development that is presented in this report.

Recent federal legislation, along with BLM policies and guidance documents, requires consideration of the potential for renewable energy development as an integral part of the land use planning process for new, revised, or amended land use plans. However, while the BLM's minerals program manuals provide guidance for assessing geothermal resources, there is no BLM guidance for assessing the potential for the solar, wind, and biomass resources. At present, resource assessments rely on federal or state programs or on developer-sponsored studies. Given these factors, the goal of this study was to provide thorough assessment of renewable energy for the BLM CCFO to use in the RMP/EIS process.

The scope of the study is limited to a resource-level assessment of renewable energy potential specifically for wind, solar and biomass resources in the planning area. The assessment of geothermal resource potential is included in the Mineral Potential Report under separate cover. Factors commonly considered in other studies that could affect resource potential, such as policy and regulatory controls, varying types of energy generation technologies, economic factors, and market trends, were not included. The BLM will consider an array of policy and regulatory factors in developing management alternatives for the RMP/EIS and in implementing the plan through review and action on ROW applications and other development proposals. The energy industry will assess market trends, determine economic feasibility, and ensure due diligence.

The methodology for the assessment focused on the collection of available information in the planning area (see Figure 2-1) and evaluation of current previous assessments by federal and state agencies, regional associations, and the renewable energy industry. Staff at the CCFO, BLM Utah State Office, Office of the Governor, and Beaver and Iron Counties were consulted. The latest GIS data, assessments, and regulatory guidance from federal and state agencies were reviewed. Renewable energy companies and utilities were contacted for information on resource development potential. The BLM's PEISs for Leasing Geothermal Resources and for wind Energy Development, and the BLM and Department of Energy's (DOE) Draft PEIS for Solar Energy Development were key sources of information. Assistance from the DOE National Renewable Energy Laboratory (NREL) was invaluable in this effort.

ES.2 Resource Overview

Wind Energy

Wind power uses the naturally occurring energy of the wind for electric power generation. Wind turbines convert wind energy to electricity via rotating blades and a generator. Electricity is fed into a utility grid and distributed to customers just as it is with conventional power plants. Utility-scale turbines are mounted on tall towers, usually 200 feet or more in height, where the wind is faster and less turbulent. A typical wind turbine has a generating capacity of 1.5 to 2 megawatts (MW). In utility-scale applications,

arrays of turbines, often called wind farms, range from a few megawatts in size to several hundred megawatts. Wind power is classified by NREL according to wind power classes, which are based on typical wind speeds. These classes range from Class 1 (the lowest) to Class 7 (the highest). Each class represents a range of mean wind power density (in watts/square meter) or the equivalent mean wind speed (meters per second or miles per hour) at the specified height above ground (50 meters was used for this study). The preparers of this report are aware that recent wind class data at a height of 80 meters above ground exists, but this information was not available for use in this analysis. In general, wind power Class 3 or higher can be useful for generating wind power with large turbines. Class 2 areas are marginal, and Class 1 areas are generally not suitable for development. However, because local terrain features can cause the mean wind energy to vary considerably over short distances, especially in hilly or mountainous terrain, some locations (e.g., exposed hilltops) even in Class 1 areas may be suitable for wind development.

For this assessment, the wind classes are divided into three categories of resource potential: low (wind classes 1 and 2), medium (wind classes 3 through 5), and high (wind classes 6 and 7). Approximately 58 percent (51,934 acres) of the lands in the medium potential category are administered by the BLM CCFO. Of the lands in the high potential category, 59 percent (3,161 acres) are administered by the CCFO. Lands with medium and high potential for wind energy typically occur on mountain ridges and in certain valleys primarily in the northwestern, northern, and northeastern portion of the planning area.

The theoretical maximum average annual capacity for wind energy on BLM-administered lands in the planning area is 380 MW. This estimate is based on the capacity factor and power density associated with each wind class and assumes that all of the available wind energy could be captured and converted to electrical energy. The estimate does not reflect any reductions in the amount of potential wind energy resulting from policy or regulatory “exclusion” or “avoidance” areas, or any reductions or adjustments resulting from technical, economic, or market constraints or limitations.

Solar Energy

The primary solar energy technologies potentially suitable for use in utility-scale applications include concentrating solar power (CSP) and photovoltaic (PV). CSP technologies use mirrors that track the sun throughout the day to concentrate the sun's rays to heat fluids or solids that, in turn, generate power. PV technologies use flat-plate solar panels that convert the sun's radiant energy directly to electricity. The plates are oriented due south at an angle from horizontal equal to the latitude of the collector’s to maximize sun exposure.

Utility-scale solar energy development requires adequate direct normal insolation (DNI), which is measured in kilowatt-hours per square meter per day (KWh/m^2/day). DNI is then portrayed on a scale from 3.0 KWh/m^2/day over 9.0 KWh/m^2/day. Under clear sky conditions, about 85 percent of sunlight is DNI and 15 percent is scattered light that comes in at many different angles. DNI can be used by both CSP and PV solar energy systems, whereas the scattered light can be used only by PV systems. Because the two technologies each use different parts of the DNI reaching the earth, the energy potential for each is determined separately.

The assessment grouped DNI levels into three categories of resource potential: low (3-5 DNI), medium (5-7 DNI), and high (7-9 DNI). The data show that 94 percent (1,970,251 acres) of BLM lands have medium potential (DNI from 5.0 - 7.0) and that the remaining 6 percent (134,721 acres) have a high potential (DNI > 7.0) for solar energy from concentrated collector systems. The assessment further shows that all BLM lands in the planning area (2,104,972 acres) are designated as having a medium potential (DNI from 5.0 - 7.0) for solar energy from PV systems.

The report further concludes that the theoretical maximum annual capacity for solar energy that could be generated by concentrated collector solar system technology on BLM-administered lands in the planning area is 109,154 MW. For a PV system, the theoretical maximum annual capacity is 101,328 MW. Estimates are based on the capacity factor and power density associated with each DNI level and assumes that all of the available solar energy could be captured and converted to electrical energy. The

estimate does not reflect any reductions in the amount of potential solar energy resulting from policy or regulatory “exclusion” or “avoidance” areas or any reductions or adjustments resulting from technical, economic, or market constraints or limitations.

Biomass Energy

Bioenergy, or biomass power, is the use of biomass (primarily wood and wood residues) to generate electricity. Biomass is also used in other energy applications such as heating. However, this assessment is limited to biomass used to generate electricity. The most common technique for generating power is the use of direct-fired boiler systems, which burn bioenergy feedstocks directly to produce steam. The steam pressure drives a turbine, which turns an electrical generator to produce electricity.

In the CCFO, woody biomass is primarily composed of the wood residues of forest restoration projects designed to improve wildlife habitat, increase forest and rangeland health, and reduce the risks of wildfire. Restoration projects consist primarily of land treatments, which thin and clear overstocked forest and woodland stands, removing understory, smaller diameter trees, and brush. Not all vegetative types have the potential for bioenergy production. In the planning area, the dominant forested species and the primary source of woody biomass with the potential for energy production are the Great Basin and Colorado Plateau pinyon-juniper.

Estimates of existing biomass resources on BLM-administered lands in the planning area are expressed in tons per acre (TPA) of biomass yield. Potential biomass yield ranges from less than 12 TPA to more than 44 TPA. This assessment groups TPA levels into three categories of resource potential: low (0-5 TPA), medium (5-20 TPA), and high (> 20 TPA). The assessment shows that 51.8 percent (1,090,308 acres) of BLM lands in the planning area have low potential for biomass energy, 44.4 percent (933,626 acres) have medium potential, and the remaining 3.8 percent (81,038 acres) have high potential for biomass energy.

The report further concludes that the theoretical maximum average annual capacity that could be generated from biomass resources on BLM-administered lands in the planning area is between 789 and 1,315 MW. In order to determine this range of values, the total number of tons of biomass material on BLM-administered lands is calculated and converted to Bone Dry Tons (BDT). Experience from completed restoration projects shows that 1 acre within the CCFO yields approximately 3-5 BDT of biomass. Based on this content and yield, there is an estimated maximum 6,314,916 - 10,524,8605 BDT of woody biomass on BLM-administered lands within the planning area. Approximately 8,000 BDTs are consumed to produce 1 MW of power. However, the theoretical maximum annual energy capacity from biomass resources could be substantially less depending on a number of factors. Those include stand density, policy or regulatory “exclusion” or “avoidance” areas, or reductions or adjustments resulting from technical, economic, or market constraints.

INTRODUCTION

1.1 Background

In May 2001 the President's National Energy Policy Development Group issued a report recommending a National Energy Policy. Among other policy recommendations, the group recommended increasing the use of renewable and alternative energy. Renewable energy includes wind, solar, geothermal and biomass resources that can be converted to electrical power at a commercial utility scale. Subsequently, on May 18, 2001, Executive Order (EO) 13212, entitled Actions to Expedite Energy Related Projects, was issued. The EO required all Executive departments and agencies to take actions to increase domestic energy production, including renewable energy, by expediting reviews of permits or other appropriate actions. In August of 2005 the Energy Policy Act of 2005 (P.L. 109-58) was signed into law, setting a national goal of 10,000 megawatts (MW) of electricity to be generated from non-hydropower renewable energy projects on public lands by 2015. Subsequent Executive and Secretarial Orders and legislation have reinforced the direction to ensure that renewable energy development is an important use of the public lands and a key contributor to the nation's energy supply.

In response to Presidential policies and Congressional legislation, the Bureau of Land Management (BLM) issued a series of agency directives and guidance to facilitate the development of renewable energy resources on the National System of Public Lands. BLM recognized at the outset that the key to making effective and efficient decisions about renewable energy projects would focus on the land use planning process and associated land use allocation decisions. The policies and guidance called for incorporating the analysis of renewable energy potential into land use plan revisions and amendments, and a process to ensure that decisions on the type and location of renewable energy development would be balanced with other uses and resource values.

Starting in 2003, the BLM and Department of Energy (DOE) initiated a series of programmatic environmental impact statements (PEISs) for renewable energy development in the western U.S. The overall objective of these PEISs was to expedite the amendment of individual land use plans throughout the BLM for renewable energy development. A PEIS for Wind Energy Development was completed in 2005, and the PEIS for Leasing Geothermal Resources was completed in 2008. A draft PEIS for Solar Energy Development was released for public comment in December of 2010. The decisions of the wind and geothermal PEISs established agency-wide policies and procedures for processing renewable energy applications. They also included lease stipulations and/or Best Management Practices (BMPs) to minimize environmental impacts, and processes for land use allocations to determine the location and allowable extent of renewable energy projects. Those policies, lease stipulations and BMPs have been adopted in many existing land use plans nationwide, including those covering the BLM Cedar City Field Office (CCFO). The Draft Solar PEIS includes proposed policies and design features for solar development that when finalized, will also be adopted by the CCFO and other land use plans.

As new Resource Management Plans (RMPs) are prepared and existing plans revised or amended, future renewable energy development is considered and analyzed in detail at the planning area level in accordance with the applicable directives and planning guidance. This report is an integral part of the BLM CCFO effort to prepare a new RMP that will replace the Pinyon Management Framework Plan (MFP) completed in 1983 and the Cedar and Beaver portions of the Cedar-Beaver-Garfield-Antimony RMP completed in 1986.

The planning area for the BLM CCFO RMP is one of several focus areas for current and future renewable energy development in the state of Utah. That development is directed at the generation of electrical power at a commercial utility scale and includes three operating geothermal power plants and an operating wind energy project, all of which are already in the planning stages for expansion. Tens of thousands of acres in the planning area are included in geothermal leases, wind project ROW applications, both for testing project areas and development, and Solar Energy Zones currently being evaluated in the Draft PEIS for Solar Energy Development, all of which are likely targets for future development. A number of factors indicate continued and potentially accelerated development of

renewable energy for the foreseeable future. They include Administration and Department of the Interior initiatives for promoting renewable energy development on the public lands, federal financial incentives for renewable energy development ,major existing and planned Interstate transmission lines and corridors and increasing demand for electricity from renewable energy projects spurred by utility Renewable Energy Portfolio incentives and standards or goals in Utah and neighboring states.

1.2 Purpose of the Report

This report presents the results of a study to assess the potential for renewable energy development on BLM-administered lands in the CCFO planning area. In accordance with BLM land use planning guidance and directives, the report identifies existing renewable energy resources, existing and pending renewable energy projects, and the different levels of renewable energy resource potential for analysis in the RMP. This is consistent with the direction in the *Preparation Plan for the Cedar City Field Office Resource Management Plan and Environmental Impact Statement,* which requires that wind, solar, geothermal, and biomass energy resource development potential data is considered in the planning effort to facilitate the processing of future renewable energy applications (BLM 2009b). Consideration of this data will also provide an opportunity to reduce the amount of additional environmental review and documentation required to process specific renewable energy project applications in the future.

The purpose of this report is also consistent with guidance in the *Land Use Planning Handbook*, which requires BLM to identify existing and potential development areas for renewable energy projects as an integral part of the land use planning process (BLM 2005a). Numerous other laws, regulations and guidance contain provisions for planning and development related to renewable energy on BLM lands. Those laws, regulations and guidance, including those for geothermal resources, are summarized in Section 1.4, below. In addition, overviews of regional and statewide renewable energy resource assessments applicable to the planning area, summaries of the decisions of the BLM Final Programmatic EIS's for Wind Energy Development and Geothermal Resources Leasing, and a summary of the proposed decisions of the Draft Programmatic EIS for Solar Energy Development are contained in the Appendices as references for use by CCFO in the preparation of the RMP and EIS.

1.3 Scope and Role in the RMP Process

The scope of the study was limited to a resource-level assessment of energy potential on BLM-administered lands in the CCFO planning area where BLM manages the surface rights. Factors commonly considered in other renewable resource assessments that could affect resource potential, such as policy and regulatory controls, potential conflicts with other resource values, varying types of energy generation technologies, economic factors, and market trends, were not included in this assessment. CCFO will consider these factors in developing management alternatives for the RMP/EIS, and in implementing the plan through review and action on right of way (ROW) applications and other development proposals. In addition, the energy industry will continue to assess market trends, determine economic feasibility, and ensure due diligence for its planned projects.

The report will assist in the development of a Reasonably Foreseeable Development Scenario (RFDS) that will forecast the location and extent of renewable energy project development in the planning area. The RFDS will contribute to the RMP/EIS, which will assess potential impacts of renewable energy development on the environment and other resource values and lands uses, and the effect that other proposed uses and resource values may have on renewable energy development. It will also assist the CCFO in developing the management alternatives for consideration in the Analysis of the Management Situation (AMS).

1.4 Applicable Policies, Regulations, and Guidance

Numerous laws, regulations, policies, and other guidance are the foundation for recent initiatives by the Department of the Interior and the BLM to integrate the development of renewable energy resources in their land use planning and management efforts. This section summarizes the key policies, regulations,

and guidance applicable to all renewable energy resources and the individual wind, solar, biomass, and geothermal resources.

All Renewable Energy Resources

The original mandate for assessing the potential for renewable energy on public lands was a directive in *National Energy Policy, Report of the National Energy Policy Development Group,* issued in May 2001. The report recommended "that the President direct the Secretaries of the Interior and Energy to re-evaluate access limitations to Federal lands in order to increase renewable energy production such as biomass, wind and solar" (p. 6-17). Following the 2001 *National Energy Policy*, additional legislation, policies, and other guidance affecting planning for renewable energy development by the BLM were adopted or issued, and are summarized below.

- *Energy Right-of-Way Corridors, BLM Instruction Memorandum 2002-196* (June 2002) provides guidance on energy-related ROW corridor and related land use planning intended to implement the National Energy Policy.

- *BLM Land Use Planning Handbook, H-1601-1* (March 2005) requires that, as a part of the land use planning process, existing and potential development areas for renewable energy projects (e.g., wind and solar) should be identified.

- *Energy Policy Act of 2005* (August 2005) recommended that the Department of the Interior (DOI) strive to approve at least 10,000 MW of renewable energy projects on public lands by 2015.

- *Energy Independence and Security Act of 2007* (December 2007) requires DOE to assess methods to integrate electric power generated at utility-scale solar facilities into regional electricity transmission systems and to identify transmission system expansions and upgrades needed to move solar-generated electricity to growing electricity demand centers throughout the United States. In addition, this section requires DOE to consider methods to reduce the amount of water consumed by concentrating solar power (CSP) systems.

- *Bureau of Land Management Energy and Mineral Policy* (August 2008) sets the BLM's policy for management of energy and mineral resources on public lands as part of the agency's multiple use mission, including environmentally sound energy and minerals development. The policy recognizes public lands as an important source of the nation's renewable energy resources, including wind. It also calls for land use plans to incorporate and consider assessments of energy resources on public lands and, when feasible, to establish partnerships with the National Renewable Energy Laboratory (NREL) and other agencies to obtain existing and new data.

- *Secretarial Order 3283* (January 2009) clarifies the DOI's roles and responsibilities to accomplish the goals for renewable energy development established in Section 211 of the Energy Policy Act of 2005.

- *Executive Order 13514* (October 2009) requires that federal agencies take efforts to align their policies to advance local planning efforts for energy development, including renewable energy, and states that agencies shall "advance regional and local integrated planning by…aligning Federal policies to increase the effectiveness of local planning for energy choices such as locally generated renewable energy."

- *NEPA Compliance for Utility-Scale Renewable ROW Authorizations, BLM Instruction Memorandum (IM) 2011-059* (February 2011) is intended to reiterate and clarify existing BLM NEPA policy to assist offices that are analyzing externally generated, utility-scale renewable energy ROW applications. Utility-scale renewable energy projects are distinct from many other types of land and realty actions due to their size and potential for significant resource conflicts, as well as the priority that has been placed on them by the DOI. The IM includes examples and

guidance applicable to renewable energy ROW applications that supplement information in the BLM's NEPA Handbook (H-1790-1).

- *Solar and Wind Applications, Due Diligence, BLM Instruction Memorandum 2011-060* (February 2011) provides additional guidance intended to avoid the potential for land speculators to file applications for solar or wind energy ROW on the public lands that may hinder other applicants with serious interests in the potential development of solar or wind energy resources on the public lands. The Instruction Memorandum (IM) proposes to address these concerns by applying the applicant qualification requirements of the ROW regulations (43 CFR 2804.12(a)(5) and 43 CFR 2804.26(a)(5)), requiring the timely submittal of a Plan of Development (POD) consistent with the requirements of the regulations (43 CFR 2804.25), and informing project applicants at the time an application is filed that ROW applications are not assignable interests under 43 CFR 2807.21.

- *Solar and Wind Applications, Pre-Application and Screening, BLM Instruction Memorandum 2011-061* (February 2011) contains a screening process designed to direct development away from lands with high conflict or sensitive resource values and toward low conflict areas such as previously disturbed sites, areas adjacent to previously disturbed or developed sites, and locations that minimize construction of new roads and/or transmission lines. Applications in high conflict areas will be more difficult to process and require a greater level of consultation, analysis, and mitigation to resolve issues. Applications with fewer resource conflicts are anticipated to be easier and less costly and time-consuming for BLM to process. Projects that avoid impacts to specially designated areas will be given a higher priority for processing.

- *Segregation of Lands, Renewable Energy, Proposed Rule, Federal Register Vol. 76., No 80, 4/26/2011* contains both proposed rulemaking and a similar Interim Temporary Final Rule that allows the BLM to temporarily segregate lands from the operation of public land laws that are included in pending or future wind or solar ROW applications, or that are identified by BLM for a potential future wind or solar ROW authorization in accordance with the ROW regulations The Interim Temporary Final Rule is effective immediately and will remain in effect for up to 2 years from the publication date during the proposed rulemaking process. Lands segregated under this rule would not be subject to appropriation under the public land laws, including location under the Mining Law of 1872, but would still be subject to leasing under the Mineral Leasing Act of 1920 and sale or other disposal of mineral materials under the Materials Act of 1947.

Wind Energy

- *Record of Decision, Final Programmatic EIS on Wind Energy Development on BLM-Administered Lands in the Western United States* (December 2005) adopted a comprehensive Wind Energy Development Program on BLM-administered lands in 11 western states, including Utah. The ROD also established policies and BMPs to mitigate impacts of wind energy projects. In addition, the Record of Decision (ROD) amended 52 BLM land use plans to include the Wind Energy Development Program policies and BMPs. The amended plans included the CCFO's Cedar-Beaver-Garfield-Antimony RMP and the Pinyon MFP.

- *Wind Energy Protocol Between the Department of Defense and BLM Concerning Consultation on Development of Wind Energy Projects* (July 2008) is an interagency agreement between the Department of Defense (DOD) and BLM intended to improve communications and coordination between the two agencies in the review of ROW applications for wind energy testing and projects on BLM administered lands that may have an adverse effect on military activities.

- *BLM Instruction Memorandum 2009-043, Wind Energy Development Policy* (December 2008) replaces interim policies and clarifies BLM wind energy development policies and BMPs contained in the ROD for Final Programmatic Wind EIS. The updated policy is intended to insure consistency in the processing of ROW applications and other authorizations for wind energy

projects on public lands. Finally, any new planning effort must comply with the policies contained in the IM.

- *BLM Right-of-Way Management Manual 2801 and Handbook H-2801-1* were both amended by the new Wind Energy Development Policy contained in IM 2009-043.

- *BLM Instruction Memorandum 2011-096 Certification of Bonding - Wind Energy Site Testing and Wind Energy Development Authorizations (April 2011)* reiterates wind authorization bonding policy contained in IM 2009-043, provides guidance for ensuring that field offices comply with bonding requirements for all wind energy right-of-way authorizations, requires that bonding information for all wind authorizations is updated in the Legacy Rehost System 2000 (LR 2000) and requires all State Directors to certify that a bond has been provided or requested for all wind energy ROW authorizations in their respective states.

Solar Energy

- *BLM Instruction Memorandum 2005-006 Solar Energy Development Policy* (October 2004) established policy for the processing of ROW applications for solar energy development projects on public lands administered by BLM and the evaluation of the feasibility of installing solar energy systems on BLM administrative facilities and projects.

- *BLM Instruction Memorandum 2007-097, Solar Energy Development Policy* (April 2007) replaced the Solar Energy Development Policy (IM No. 2005-006) and established policy for the processing of ROW applications for solar energy development projects on public lands administered by the BLM and the evaluation of the feasibility of installing solar energy systems on BLM administrative facilities and projects.

- *Secretarial Oder 3285A1* (March 2009) set a goal of identifying and prioritizing specific locations best suited for large scale production of solar energy on public lands. It requires DOI agencies and bureaus to work collaboratively to encourage development of renewable energy and associated transmission while protecting the environment and to establish clear policy direction for authorizing the development of solar energy on public lands. On February 22, 2010, Secretarial Order 3285 was amended to clarify Departmental roles and responsibilities in prioritizing development of renewable energy. The amended order is referred to as Secretarial Order 3285A1.

- *Instruction Memorandum 2010-141, Solar Energy Interim Rental Policy* (June 2010) provides updated guidance on the rental provisions of ROW authorizations for solar energy projects on public lands administered by the BLM.

- *Instruction Memorandum 2011-003, Solar Energy Development Policy* (October 2010) provides updated guidance on the processing of ROW applications and the administration of ROW authorizations for solar energy projects on public lands administered by the BLM.

Biomass Energy

- *Executive Order 13134, Developing and Promoting Biobased Products and Bioenergy* (1999) called for a comprehensive strategy to stimulate technologies to make biobased products and bioenergy cost-competitive in national and international markets.

- *Biomass Research and Development Act of 2000* established mechanisms for interagency coordination on biomass technologies including the Biomass Research and Development Technical Advisory Committee and the Biomass Research and Development Board.

- *Farm Bill 2002* included a number of authorizations related to renewable energy development and bioenergy.

- *Healthy Forests Restoration Act of 2003* encouraged biomass energy production through grants and assistance to local communities creating market incentives for removal of otherwise valueless forest material.

- *Memorandum of Understanding on Policy Principles for Woody Biomass Utilization for Restoration and Fuel Treatments on Forests, Woodlands, and Rangelands* (2003) was signed by the departments of Agriculture, Energy, and Interior and encouraged opportunities to provide a reliable sustainable supply of wood biomass and the sustainable development and stabilization of woody biomass markets.

- *Food Conservation and Energy Act of 2008* provided grants and financial incentives for investment in renewable technologies to use agricultural and forestry crops for bioenergy.

Geothermal Energy

- *Mineral Leasing Act of 1920* (as amended) contains the statutes that provide overall guidance to the BLM on mineral leasing, including geothermal development.

- *Mining and Mineral Policy Act of 1970* requires federal agencies to encourage the development of mineral resources, including geothermal resources, on federal lands.

- *BLM Manual 2881 – Mineral Leasing Act* provides overall guidance to BLM on mineral leasing procedures.

- *BLM Manual 3031 – Energy and Mineral Resource Assessment (1985)* provides guidance and sets standards for gathering and analyzing information on energy and mineral resources, including geothermal resources, for land use decisions.

- *BLM Manual 3060 – Mineral Reports Preparation and Review* (1994) provides guidelines for preparation and review of energy and mineral resources reports.

- *Geothermal Steam Act of 1970*, which was amended and supplemented by the Energy Policy Act of 2005, provides statutory guidance for geothermal leasing by the BLM.

- *Memorandum of Understanding: Implementation of Section 225 of the Energy Policy Act of 2005 Regarding Geothermal Leasing and Permitting* (2006) established procedures for processing geothermal lease applications, a program to reduce the backlog of pending geothermal lease applications, and a data retrieval system for tracking lease and permit applications.

- *Advanced Geothermal Energy Research and Development Act of 2007* called for programs of research, development, demonstration, and commercial application to expand the use of geothermal energy production.

1.5 Key References and Studies

All Renewable Energy Resources

A number of current and previous studies contributed to the analysis of renewable energy potential for the CCFO RMP. All of the studies are listed in the References section. The following studies contain methodologies for and assessments of multiple renewable energy resources (solar, wind, geothermal, and biomass) and therefore contributed to the overall assessment in this report. The sections that follow list the studies and reports specific to each resource (wind, solar, geothermal, or biomass).

- *Assessing the Potential for Renewable Energy on Public Lands* (2003). This study was conducted by the BLM, NREL, and the DOE following issuance of the 2001 National Energy Policy. It proposes, and applies, methodologies for evaluating the potential for solar, wind, geothermal, and biomass resource development on BLM-administered lands in the Western United States.

- *Western Renewable Energy Zones (WREZ), Phase 1: QRA Identification Technical Report* (2009). This study was conducted by NREL for the Western Governor's Association. It assessed the potential for large-scale development of solar, wind, geothermal, biomass, and hydropower resources in the Western United States and Canada. During the first phase, renewable energy resources with the potential for utility-scale development were identified. The next step was to identify Candidate Study Areas (CSAs), or areas with the highest number of cost-effective renewable resources. The CSAs were then screened for land use restrictions, regulatory limitations, and environmental factors. That screening defined Qualified Resource Areas (QRAs) as those areas with potential generation capacity sufficient to justify the construction of new regional transmission facilities. Clusters of QRAs are designated as "hubs" within each state for the purpose of evaluating interstate transmission. Utah contains one hub (UT_WE) that encompasses much of the RMP planning area. Appendix A contains a summary of the WREZ Phase I report, including a map of the UT_WE Hub.

- *Utah Renewable Energy Zones Task Force Phase 1 Report: Renewable Energy Zone Resource Identification* (2009). This study was conducted jointly by the Utah Geological Survey and NREL. It presented the results of a screening-level study that identified the location of renewable resources and estimates of the theoretical potential of electrical energy from solar, wind, and geothermal resources. The report designates 27 Renewable Energy Zones (REZs) in the state, within which there is the greatest potential for large-scale energy production. Several REZs are identified within the RMP planning area. Appendix B contains a summary of the UREZ Phase I report, including a map of the REZs within the planning area.

Wind Energy

- *Final Programmatic EIS on Wind Energy Development on BLM-Administered Lands in the Western United States* (December 2005). The PEIS adopted a comprehensive Wind Energy Development Program on BLM-administered lands in 11 western states, including Utah. It also established policies and BMPs to mitigate impacts of wind energy projects and proposed amendments to 52 BLM land use plans to include the Wind Energy Development Program policies and BMPs. The amended plans included the CCFO's Cedar-Beaver-Garfield-Antimony RMP and the Pinyon MFP. Appendix C contains a summary of the Final Wind PEIS.

- *Wind Energy Atlas of the United States* (1986) and *Wind Energy Atlas of the United States, Volume 8: The Southern Rocky Mountain Region* (1981). Both studies were prepared by the Pacific Northwest Laboratory (PNL) for the DOE. A national wind resource assessment was one of the initial goals of the Federal Wind Energy Program. Methods for estimating the distribution and magnitude of wind resources developed by the PNL were used to prepare 12 regional wind energy atlases covering the United States and its territories.

Solar Energy

- *Draft Programmatic EIS for Solar Energy Development in Six Southwestern States* (December 2010). The Draft PEIS is assessing proposed actions by the BLM and DOE to facilitate solar energy development. These actions include the evaluation of a new Solar Energy Program for utility-scale solar energy development on BLM-administered lands in six southwestern states (Arizona, California, Colorado, Nevada, New Mexico, and Utah). The PEIS focuses on designated Solar Energy Zones (SEZs). SEZs, defined by the BLM as having few impediments to utility-scale production of solar energy, are zones where BLM would prioritize solar energy and associated transmission infrastructure development. The three SEZs designated in Utah (Wah Wah Valley,

Milford Flats South, and Escalante Valley) are located in the planning area. Appendix D contains additional information on the Draft PEIS, including a map of the SEZs in the RMP planning area.

Biomass Energy

- *A Geographic Perspective on the Current Biomass Resource Availability in the United States* (2005). This was prepared by NREL and estimates the technical biomass resources available in the United States based on analysis of biomass feedstock data using Geographic Information System (GIS) technology.

- *Potential for Using Woody Biomass for Heat and/or Power in Utah's Institutions and Industries* (2006). Prepared by the Utah Department of Natural Resources, this document assesses woody biomass potential in the state and its potential use in converting existing boilers to wood-fueled boilers in public and private buildings.

Geothermal Energy

- *Final Programmatic Environmental Impact Statement for Geothermal Leasing in the Western United States* (2008). The PEIS analyzed the impacts of geothermal leasing on BLM and National Forest System lands with medium and high potential for geothermal resources. The decisions in the ROD facilitated the processing of existing lease applications by determining what lands were appropriate for leasing and the stipulations that should be applied to geothermal leases. The ROD amended the Cedar-Beaver-Garfield and Antimony RMPs and the Pinyon Management Framework Plan (MFP) to allocate lands available for geothermal leasing, and included lease stipulations and BMPs. Appendix E contains a summary of the Geothermal PEIS and ROD.

RENEWABLE ENERGY ASSESSMENT

2.1 Introduction

The methodology for this resource-level assessment of renewable energy potential included collecting available information for the planning area (see Figure 2-1) and evaluating current and previous studies. Staff at the CCFO, BLM Utah State Office, Office of the Governor, and Beaver and Iron Counties were consulted. The latest GIS data, assessments, and regulatory guidance from federal and state agencies were reviewed. Renewable energy companies and utilities were contacted for information on resource development potential. The BLM's Programmatic EISs for geothermal and wind energy and the DOE Draft Solar Energy PEIS were key sources of information. Assistance from NREL was invaluable in this effort.

At present, BLM guidance for the assessment of renewable energy is limited to geothermal resources, leaving current efforts to rely on federal, state, or industry studies. Those studies, and their methods of assessing resource potential, were reviewed for their application to the planning area. The result was a two-part methodology that a) utilized available numerical data as the basis for quantitative analysis, conclusions and discussion, and b) produced a qualitative scale that distills the numerical data and displays resource potential in a manner that is both simple and consistent for all of the resources assessed in this report. Numerical data on resources is displayed in units such as kWh/m2/day, megawatts, wind density class, or bone dry tons per acre and expressed in quantitative measures of renewable energy potential. Conclusions regarding that quantitative potential, however, are also expressed on a qualitative scale (low, medium, and high) that can be consistently applied throughout the process of developing and implementing the RMP.

2.2 Wind Energy

Overview

Wind power uses the natural energy of the wind for electric power generation. Wind turbines convert wind energy to electricity via rotating blades and a generator. Electricity is fed into a utility grid and distributed to customers just as it is with conventional power plants. Utility-scale turbines are mounted on tall towers, usually 200 feet or more in height where the wind is faster and less turbulent. A typical turbine has a generating capacity of 1.5 to 2 MW. In utility-scale applications, arrays of turbines, often called wind farms, range from a few megawatts in size to several hundred megawatts.

In the United States, the current installed capacity of wind energy projects is over 21,000 MW. The BLM manages 20.6 million acres of public lands with wind potential. By 2010, the BLM had authorized 29 wind projects nationwide with a total capacity of 437 MW. In Utah, the greatest potential for utility-scale wind power is in the southwestern part of the state between the towns of Delta and Milford in the Escalante Valley. At the end of 2010, Utah had 223 MW of installed wind capacity, much of it within the CCFO RMP planning area, and including Milford wind projects. (BLM, 2011c)

Existing and Pending Development

The following sections summarize authorized and pending CCFO permits for wind energy development in the planning area. Not included are six permits for wind testing and two permits for development that have been denied or closed. The locations of those projects are shown in Figures 2-2 and 2-3.

Authorized Development

Authorized wind energy development in the planning area is summarized in Table 2-1 and shown in Figure 2-2. As of February 2011, two wind energy projects had been approved by the CCFO in the Milford Wind Development Corridor. Together, the projects have 61 wind turbines on BLM administered land of 197 total, with a generating capacity of 91.5 MW. First Wind's Milford Phase I project is now operational with 28 wind turbines (42 MW) on BLM lands and 55 turbines on private land.

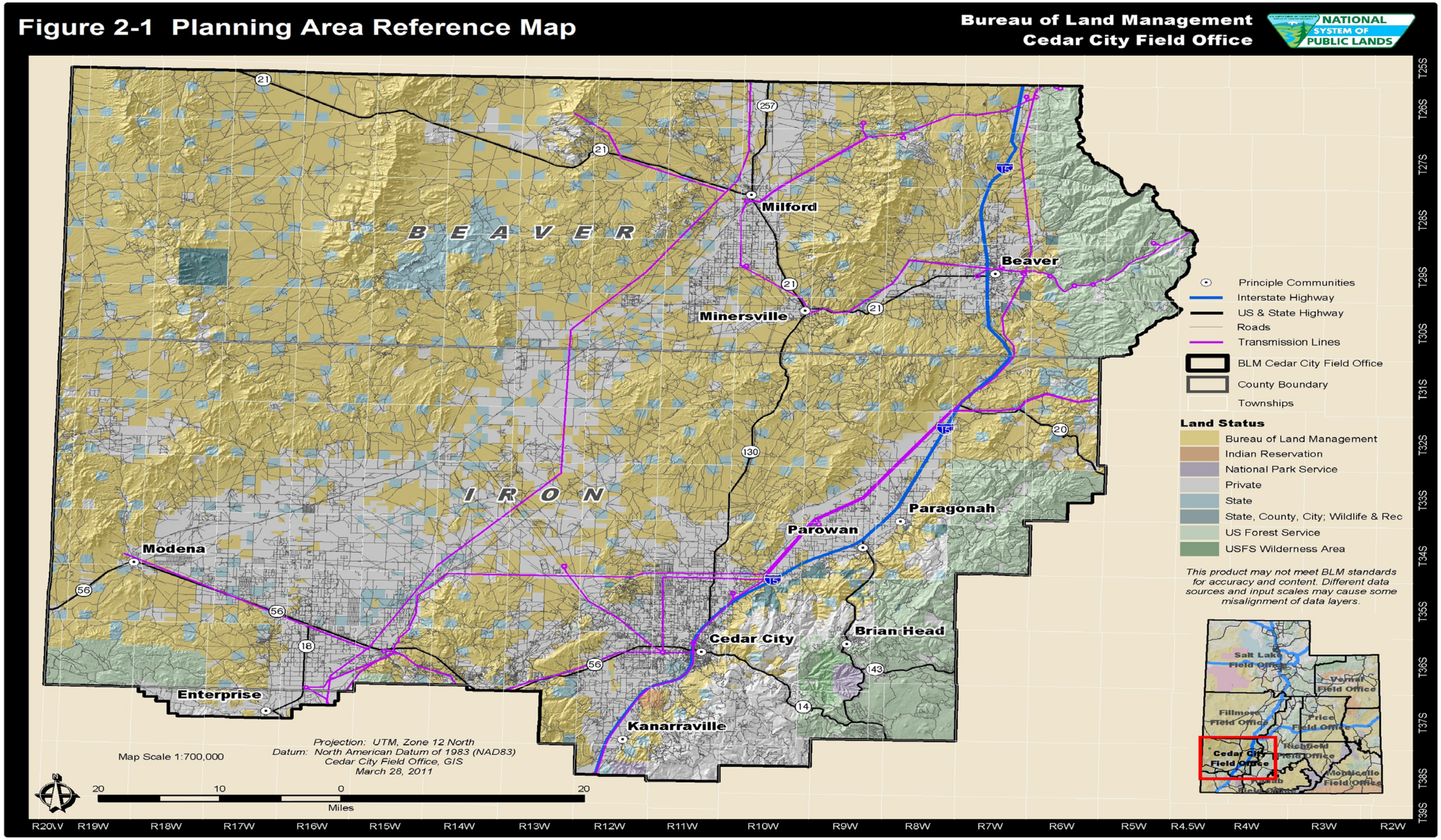
Figure 2-1 Planning Area Reference Map
Bureau of Land Management
Cedar City Field Office
NATIONAL SYSTEM OF PUBLIC LANDS
B E A V E R
I R O N
Milford
Beaver
Minersville
Modena
Paragonah
Parowan
Cedar City
Brian Head
Enterprise
Kanarraville
Principle Communities
Interstate Highway
US & State Highway
Roads
Transmission Lines
BLM Cedar City Field Office
County Boundary
Townships
Land Status
Bureau of Land Management
Indian Reservation
National Park Service
Private
State
State, County, City; Wildlife & Rec
US Forest Service
USFS Wilderness Area
This product may not meet BLM standards for accuracy and content. Different data sources and input scales may cause some misalignment of data layers.
Salt Lake Field Office
Vernal Field Office
Fillmore Field Office
Price Field Office
Cedar City Field Office
Richfield Field Office
Monticello Field Office
Map Scale 1:700,000
Projection: UTM, Zone 12 North
Datum: North American Datum of 1983 (NAD83)
Cedar City Field Office, GIS
March 28, 2011
20 10 0 20
Miles
T25S T26S T27S T28S T29S T30S T31S T32S T33S T34S T35S T36S T37S T38S T39S
R20W R19W R18W R17W R16W R15W R14W R13W R12W R11W R10W R9W R8W R7W R6W R5W R4.5W R4W R3W R2W

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In May of 2010, the Cedar City and Fillmore FOs approved the Milford Phase II construction of 33 additional turbines (49.5 MW) on BLM administered land. In addition to wind project facilities, 5 grants are authorized for 23 wind meteorological ("met") towers on 96,708 acres.

Table 2-1: Authorized Wind Energy Development

Project Name	Acres	Date	Status
Testing			
enXco Mineral Mountain Testing	4,707	2/10/09	ROW Renewed
MWC Milford Testing	35,555	5/7/08	ROW Granted-Issued
Wasatch Wind Harmony Mtn Testing	13,128	8/25/08	ROW Granted-Issued
Ridgeline Wah Wah Testing	33,305	3/8/10	ROW Granted-Issued
Energy Unlimited Enterprise Testing	10,013	3/15/10	ROW Granted-Issued
Project Development			
Milford Wind Phase I Development	59	10/15/08	ROW Granted-Issued
Milford Wind Phase II Development	35	2/9/10	Authorized/Amended/Modified
Milford Wind Phase II Temp Staging/Laydown	11	5/4/10	ROW Granted-Issued

Source: Rob Wilson, Lands and Realty Specialist, BLM CCFO, 2011

Pending Development

Pending wind energy development applications in the planning area are summarized in Table 2-2 and shown in Figure 2-2. As of February 2011, the CCFO had five pending ROW applications for wind met towers on approximately 204,238 acres. Ongoing challenges to these applications include applicants that apply for a single met tower installation as a means to hold land for speculation, protracted consultations with the DOD on Military Operational Areas, and delays resulting from incomplete ROW applications.

Table 2-2: Pending Wind Energy Development

Project Name	Acres	Date	Status
Testing			
enXco Mineral Mountain II Testing	Not yet determined	12/14/06	Application Received
enXco Gillies Hill Testing	3,360	4/10/08	Application Received
Mormon Mesa CCFO Testing	129,756	9/19/07	Application Received
Wah Wah Wind Wah Wah Testing	71,120	6/2/10	Application Received
Wah Wah Wind Pine Valley Testing	Not yet determined	11/18/10	Application Received
Project Development			
enXco Mineral Mountain Development	4,717	11/12/08	Application Received
Wasatch Wind Harmony Development	4,183	5/22/09	Application Received

Source: Rob Wilson, Lands and Realty Specialist, BLM CCFO, 2011

Two wind development project ROW applications are currently pending in the CCFO. The Harmony Mountain Wind Project (43 turbines) is awaiting the completion of DOD consultation, which has been ongoing for more than a year. The Mineral Mountain Wind Project (53 turbines) has been postponed due to the need for additional wind testing. BLM is currently awaiting a decision by the project applicant to either proceed with the ROW approval or to withdraw the application. In June of 2010, First Wind submitted a cost recovery agreement to the Fillmore Field Office (FFO) as part of the Milford Wind Corridor Phase III ROW application. Phase III calls for construction of approximately 275 turbines (300-400 MW) on 44,000 acres.

Assessment of Wind Energy Resource Potential

This section presents the results of a baseline resource-level assessment of wind energy resources in the RMP planning area. Accordingly, its focus is on factors such as geographic distribution and location, topography, wind speed, and overall potential for renewable energy generation. Regulatory and policy factors such as wilderness areas, critical habitat, and other land management constraints will be addressed by the CCFO during the RMP revision process as well as subsequently during review and evaluation of individual permit applications. Technical, economic, and market factors are also not included in the assessment criteria because they reflect trends that are subject to change and, therefore, best left to developers and utilities as part of their planning analyses. However, a general overview of technical and economic factors that could influence wind energy development in the planning area is included.

Existing Wind Resources

The DOE's Wind Program and the NREL publish wind resource maps for the state of Utah. (NREL 2011a) Wind is classified according to wind power classes, which are based on typical wind speeds. These classes range from Class 1 (the lowest) to Class 7 (the highest) as shown in Figure 2-2. Each class represents a range of mean wind power density (in watts/square meter) or the equivalent mean wind speed (meters per second or miles per hour) at the specified height above ground. The relationship of wind power class to wind speed and wind power density at 50 meters is summarized in Table 2-3. The preparers of this report are aware that recent wind class data at a height of 80 meters above ground exists, but this information was not available for use in this analysis. Note that each wind power class represents a range between two wind power densities or wind speeds. For example, wind power class 3 represents the range in wind speed from 6.4 to 7.0 meters per second.

Table 2-3: Classes of Wind Power Density at 50 Meters

Wind Power Class	Wind Power Density (W/m^2)	Speed m/s (mph)
1	0	0
	200	5.6 (12.5)
2		
	300	6.4 (14.3)
3		
	400	7.0 (15.7)
4		
	500	7.5 (16.8)
5		
	600	8.0 (17.9)
6		
	800	8.8 (19.7)
7		
	2000	11.9 (26.6)

Source: Elliott, 1986

In general, at 50 meters wind power areas in class 3 or higher can be useful for generating wind power with large turbines. Areas in Class 4 and above are considered good resources. Some locations in Class 3 areas could have higher wind power class values at 80 meters than 50 meters because of possible high wind shear. Given the advances in technology, a number of locations in the Class 3 areas may be suitable for utility-scale wind development. Class 2 areas are marginal, and Class 1 areas are generally not suitable for development. However, because local terrain features can cause the mean wind energy to vary considerably over short distances, especially in hilly or mountainous terrain, some locations (e.g., exposed hilltops) in Class 1 areas may be suitable for wind development (Elliott, 1986).

Figure 2-2 shows how wind classes are distributed on the 2,104,972 acres of land administered by the CCFO. The figure also shows the general locations of authorized and pending BLM ROW applications for meteorological wind testing and wind project development on BLM lands and of authorized wind testing facilities on private land. The currently operating Milford Wind Phase I and II projects are shown near the northern boundary of the planning area. The locations of authorized and pending wind energy development reflect the selection by developers of sites with higher wind energy classes and corresponding average wind speed. Those sites typically occur on mountain ridges and in certain valleys.

Table 2-4 summarizes the distribution of wind class by land ownership on all lands within the planning area. The table shows that 97 percent (3,659,942 acres) of all lands in the planning area are in wind classes 1 and 2, or those classes with the lowest wind energy potential. The remaining 3 percent (94,750 acres) are in wind class 3 or higher, indicating moderate to high potential for wind energy. Of the 94,750 acres in wind class 3 or higher, 58 percent (55,094 acres) are on lands administered by the CCFO.

Table 2-4: Wind Class by Land Ownership

Wind Energy Class	Land Ownership (Acres)						Total
	BLM	IR	NPS	Private	State	USFS	
1	1,602,778	869	6,257	689,535	225,815	283,928	2,809,182
2	447,099	1,507	1,521	274,051	75,093	51,489	850,760
3	38,682	127	937	11,636	4,421	11,640	67,444
4	9,440	-	136	1,704	914	3,942	16,137
5	3,811	-	-	390	183	1,438	5,822
6	2,331	-	-	180	88	1,384	3,982
7	830	-	-	10	19	506	1,365
Total	2,104,972	2,503	8,851	977,506	306,533	354,327	3,754,692

Source: NREL and CCFO GIS Data, 2011
BLM: Bureau of Land Management
IR: Indian Reservation
NPS: National Park Service
USFS: U.S. Forest Service

Wind Energy Potential

Based on the NREL studies and other sources reviewed for this report, the criteria shown in Table 2-5, below, were used as qualitative indicators of wind energy potential in the RMP planning area. The assessment criteria were applied in order to generate a map of overall wind energy potential in the RMP planning area.

The results are shown in Figure 2-3 and summarized in Table 2-6. The figure shows the distribution of wind energy development potential in each of the three categories (low, medium, and high) in relation to wind power class.

Table 2-5: Wind Energy Potential Assessment Criteria

Wind Class	Energy Potential
1	Low
2	
3	Medium
4	
5	
6	High
7	

Source: JBR, 2011

Table 2-6: Wind Energy Potential by Land Ownership

Land Ownership	Wind Energy Potential (Acres)			Total
	Low	Medium	High	
Bureau of Land Management	2,049,877	51,934	3,161	2,104,972
Indian Reservation	2,376	127	-	2,503
National Park Service	7,778	1,073	-	8,851
Private	963,586	13,730	189	977,506
State	300,908	5,517	107	306,533
US Forest Service	335,417	17,021	1,890	354,327
Total	3,659,942	89,402	5,348	3,754,692

Source: JBR and CCFO GIS Data, 2011

Table 2-6 shows that 2.4 percent (89,402 acres) of the RMP planning area is classified as having medium wind energy potential (wind classes 3 – 5) and less than 1 percent of lands are classified as having a high potential for wind energy development (classes 6 and 7). Of the lands in the medium potential category, 58 percent (51,934 acres) are administered by the BLM CCFO. Of the lands in the high potential category, 59 percent (3,161 acres) are administered by the CCFO.

Power Capacity and Generation

Table 2-7 presents an estimate of the theoretical maximum wind energy that would be available on BLM-administered lands when NREL technical criteria are applied, assuming all of the available wind energy can be captured and converted to electrical energy. The estimate is based on the capacity factor and power density associated with each wind class. The estimate does not reflect any reductions in the amount of potential wind energy resulting from policy or regulatory "exclusion" or "avoidance" areas that may be applied during implementation of the RMP and review of ROW and other applications by the CCFO. Further, it doesn't reflect any reductions or adjustments resulting from technical, economic, or market constraints or limitations. Those factors are discussed in more detail in the section that follows. Based on NREL criteria, the table shows an estimated average annual capacity of 380 MW of wind energy on BLM lands. When annual capacity is converted to generation, BLM lands represent an estimated 3.3 million MWh.

Table 2-7: Annual Wind Energy Capacity and Generation on BLM Lands

Wind Class on BLM Lands	Capacity Factor[1]	Power Density (MW/km^2)	Square Kilometers	Average Annual Capacity (MW)[3]	Average Annual Generation (MWh)[4]
3	0.32	5.00	157	251	2,195,796
4	0.36	5.00	38	69	602,858
5	0.42	5.00	15	32	283,942
6	0.44	5.00	9	21	181,930
7	0.46	5.00	3	8	67,743
Total			223	380	3,332,269

Source: NREL, 2011
[1] Percentage of time power is being generated
[2] Measured in MW per square kilometer
[3] = Capacity Factor x Power Density x Square Kilometers
[4] = Average Annual Capacity x 8,760 hours/year

Factors Affecting Resource Development Potential

This report focuses on the resource-level potential for wind energy development. The scope of the study was limited to baseline screening criteria most commonly used by the wind energy industry and federal agencies involved in the ongoing study of wind energy and resource development, such as NREL and DOE. For wind energy, the baseline criteria for assessing wind energy potential, is wind class, as described above. However, there are numerous other factors that can significantly affect the viability of wind energy development in any given locale. Those additional factors can be generally described in one of two broad categories: (1) policy and regulatory and (2) economic and technical. The most common factors in each of these categories are summarized below.

Policy and Regulatory Factors

Policy and regulatory factors are those that involve regulation, management, and administration of BLM lands within the RMP planning area and which may affect the location, size, configuration, and operation of a wind energy facility. Many of the NREL and other recent studies apply some level of screening using "exclusion" and "avoidance" criteria. In particular, the *Solar Energy Draft PEIS* and *Western Renewable Energy Zone (WREZ) Initiative Phase 1 Report* apply a significant number of screening criteria reflecting potential constraints to renewable energy development imposed by policies and regulations (WREZ 2009).

Most recently the BLM issued *IM 2011-061 Solar and Wind Applications, Pre-Application and Screening* (February 2011). The IM contains a screening process designed to direct development away from lands

with high conflict or sensitive resource values and toward low conflict areas such as previously disturbed sites, areas adjacent to previously disturbed or developed sites, and locations that minimize construction of new roads and/or transmission lines. Applications in high conflict areas will be more difficult to process and require a greater level of consultation, analysis, and mitigation to resolve issues. Applications with fewer resource conflicts are anticipated to be easier and less costly and time-consuming for BLM to process. Projects that avoid impacts to specially designated areas will be given a higher priority for processing. Consistent with IM 2011-061, the BLM will use the following screening criteria to assist in the processing of wind energy development ROW applications (BLM, 2011d).

Low Potential for Conflict – timely or expedited authorizations possible:

- Lands specifically identified for solar or wind energy development in BLM land use plans.
- Previously disturbed sites or areas adjacent to previously disturbed or developed sites.
- Locations that minimize construction of new roads and/or transmission lines.
- Lands adjacent to designated transmission corridors.
- Lands currently designated as Visual Resource Management Class IV.
- Lands identified as suitable for disposal in BLM land use plans.

Medium Potential for Conflict – projects that have resource conflicts that can potentially be resolved:

- Designated BLM special management areas, including Areas of Critical Environmental Concern (ACEC) areas.
- Lands with wilderness characteristics outside Wilderness and Wilderness Study Areas.
- Right-of-way avoidance areas.
- Areas listed in the National Register of Historic Places or other sensitive areas such as National Natural Landmarks and National Historic Landmarks.
- Areas with National Historic and Scenic Trails and National Recreation Trails.
- Sensitive habitat areas, or areas of importance for federal or state sensitive species.
- Lands currently designated as Visual Resource Management Class III.
- DOD operating areas, including significant radar, airspace, or land use conflicts.
- Areas where project development may adversely affect lands acquired for conservation purposes.
- Developed recreation sites and/or facilities.
- Projects with proposed groundwater uses within groundwater basins that have been over-appropriated by state water resource agencies.

High Potential for Conflict – more complex projects that will require a greater level of consultation, analysis, and mitigation to resolve issues or that may not be feasible to authorize:

- Lands near or adjacent to units of the National Park System, Fish and Wildlife Service Refuge System, National Forest System, and the BLM National Landscape Conservation System.
- Lands adjacent to Wild, Scenic, and Recreational Rivers and river segments determined eligible/suitable for Wild or Scenic River status.
- Designated critical habitat for federally threatened and/or endangered species.
- Lands currently designated as Visual Resource Management Class I or Class II.
- Right-of-way exclusion areas.
- Lands currently designated as no surface occupancy (NSO) in BLM land use plan prescriptions. *Economic and Technical Factors*

Following are examples of technical and economic factors tha*t* may affect the siting and development of wind energy projects. The examples included after each factor are from various NREL wind assessments and the *UREZ Phase 1 and 2* studies and will vary with each individual project.

- Distance and access to existing or proposed transmission lines or corridors (e.g., within 25 miles).
- Available transmission capacity (e.g., 69-345 kV).
- Access and distance to roads and highways (e.g., 50 miles).
- Distance to population centers (e.g., not less than 5 miles).
- Proximity to urban area for operations and maintenance (e.g., within 50 miles).
- Optimal elevation (e.g., maximum of 7,000 feet).
- Slope of land area (e.g., doesn't exceed 14 percent).
- Minimum parcel size (e.g., 20 MW per square mile).
- Wind turbine array density (e.g., 5-7 MW per square kilometer is typical).
- Wind turbine technology (e.g., the *UREZ Phase 1* study used the General Electric model 1.5sle wind turbine as one of many criteria in estimating the State of Utah's wind energy power generation potential).
- Renewable energy financial incentives from federal or state governments (e.g., federal and State of Utah production tax credits).
- Cost of generation (including operations and maintenance, equity investment in capital, financing, and taxes).
- Transmission interconnection costs.

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Figure 2-2 Existing Wind Energy Resources

Bureau of Land Management
Cedar City Field Office

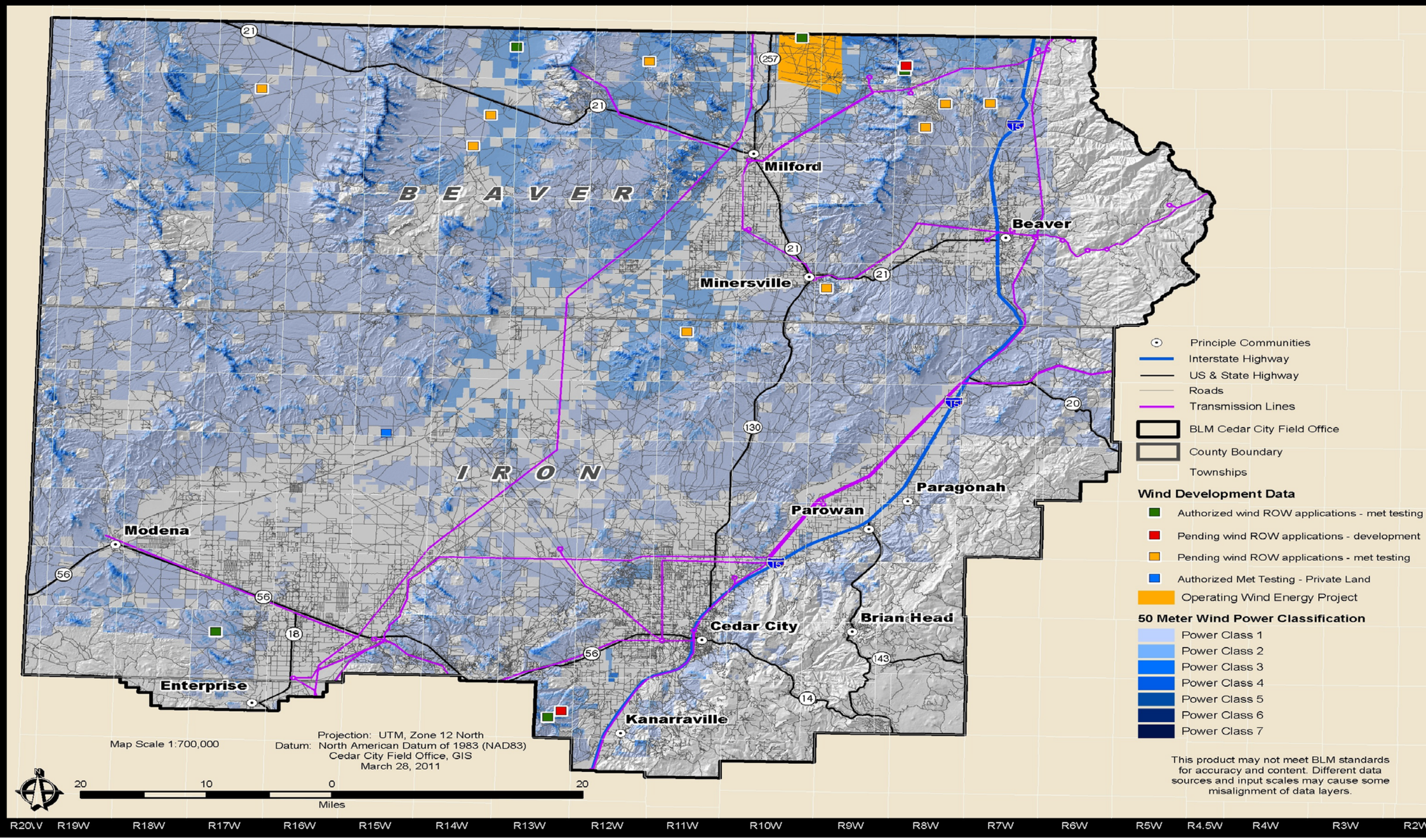

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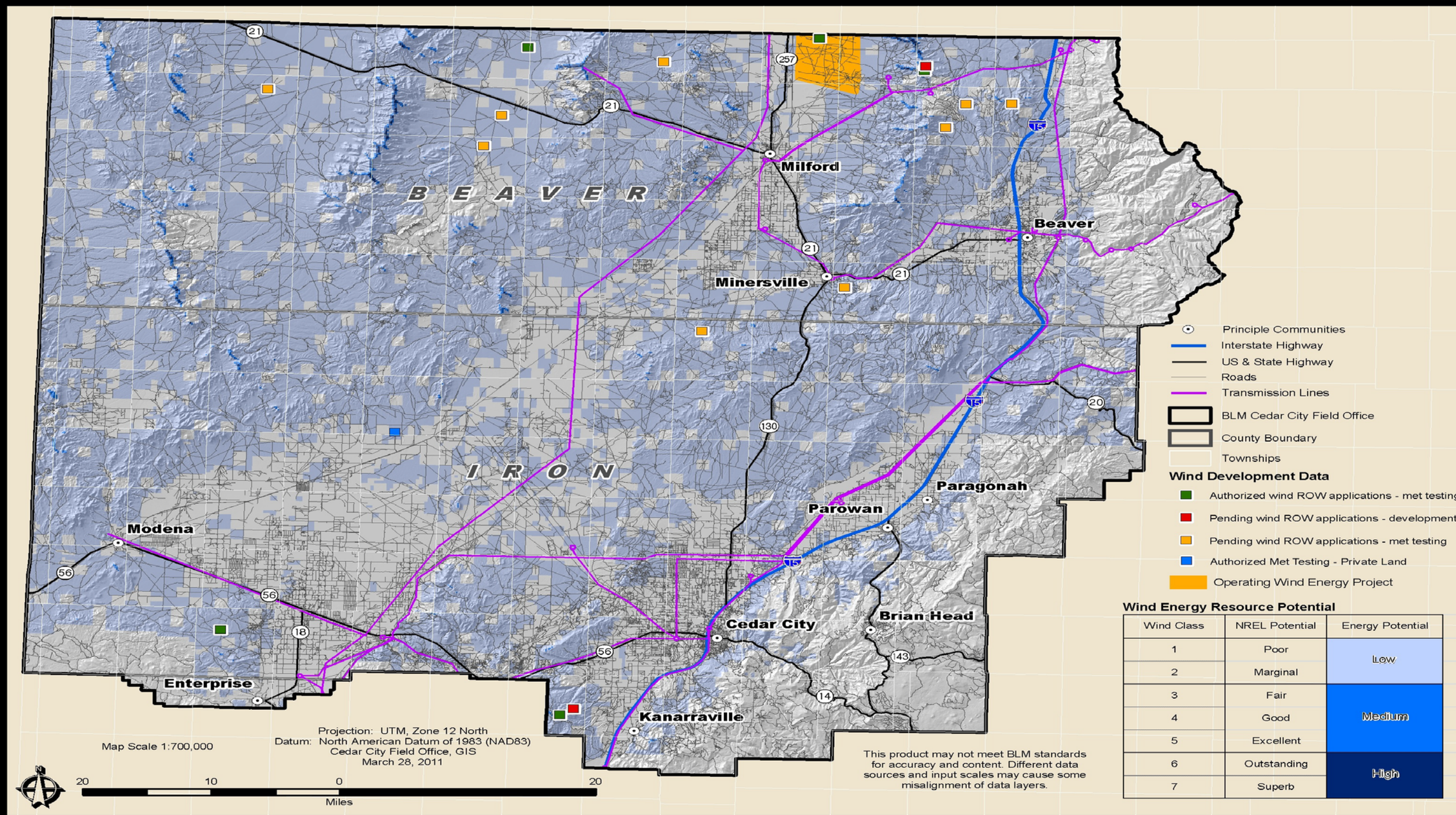
Figure 2-3 Wind Energy Resource Potential

Bureau of Land Management
Cedar City Field Office



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2.3 Solar Energy Resources

Overview

Solar radiation can be converted directly to usable energy through a variety of technologies, and that energy can be used for small-scale applications such as powering hand-held calculators, powering solar vehicles, or heating water for residential applications or for large-scale commercial applications such as generating electricity in solar power plants. This assessment of solar energy potential in the CCFO RMP planning area focuses on utility-scale facilities, or those facilities that can generate large amounts of electricity to be put directly into the electricity transmission grid. Solar energy technologies potentially suitable for use in utility-scale applications include concentrating solar power technologies (CSP) and photovoltaic technologies (PV).

CSP, or concentrating collector, technologies track the sun throughout the day and use mirrors to concentrate the sun's rays to heat fluids or solids that, in turn, generate power. There are three main types of CSP systems. *Linear concentrator* systems collect the sun's energy using long rectangular, curved (U-shaped) mirrors tilted toward the sun, focusing sunlight on tubes (or receivers) that run the length of the mirrors. A *dish/engine* system uses a mirrored dish similar to a very large satellite dish that directs and concentrates sunlight onto a thermal receiver, which absorbs and collects the heat and transfers it to the generator. A *power tower* system uses a large field of flat, sun-tracking mirrors known as heliostats to focus and concentrate sunlight onto a receiver on the top of a tower, where a heat-transfer fluid is heated to generate steam for a conventional turbine generator (NREL, 2011c).

PV technologies convert the sun's radiant energy directly to electricity, rather than first converting it to heat that is then used to generate electricity. PV technologies use flat-plate solar panels that are oriented due south at an angle from horizontal equal to the latitude of the collector’s location. Today, thousands of homes and businesses are powered with individual solar PV systems. Utility companies are also using PV technology for large power stations. While PV systems are currently more expensive than CSP systems for utility scale power generation, they are becoming more cost effective and will be more competitive with CSP systems in the future. PV systems have a distinct advantage over CSP systems in their ability to generate electricity over a larger portion of the country. Under clear sky conditions, about 85 percent of sunlight is direct and 15 percent is diffuse, or scattered, light that comes in at many different angles reflected by clouds. PV systems use flat plates tilted toward the sun that can collect both direct and diffuse solar rays allowing them to be used even in parts of the country where there is more cloud cover. For CSP technologies, on the other hand, the energy collecting lenses must be pointed directly at the sun and track it throughout the day because it can collect energy from only direct solar rays. Due to this constraint, the use of CSP systems is limited only to the sunniest parts of the country where cloudless days dominate. (DOE, 2011b).

The BLM manages 22 million acres of public lands in six states (including Utah) that have solar potential. Nationally, BLM has approved 8 solar energy projects on public lands with a total generating capacity of 3,572 MW. There are currently no active ROW applications for solar development on BLM-administered lands in the CCFO RMP planning area. However, there is a proposal on private land in Iron County for a 650-acre PV facility with an installed generating capacity of 100 MW.

Existing and Pending Development

Approved Solar Energy Development

As of February 2011, there are no authorized or operating solar energy facilities on BLM-administered lands in the CCFO RMP planning area.

Pending Permit Activity

As of February 2011, the BLM CCFO had no pending ROW applications for solar energy facilities on BLM-administered lands in the CCFO RMP planning area. In 2008, applications were submitted for a 2,240-acre 250 MW concentrating solar facility. However, the applications were withdrawn in April of

2009. In February of 2011, Scatec Solar announced plans for a 650-acre PV solar facility on private land near Parowan in Iron County. The completed facility will have an installed generating capacity of 100 MW (Stowell, 2011).

Assessment of Solar Energy Resource Potential

This report presents the results of a baseline resource-level assessment of solar energy resources in the RMP planning area. Accordingly, its focus is on factors such as geographic distribution and location, topography, and overall potential for renewable energy generation. Regulatory, policy, and other factors such as wilderness areas, critical habitat, and other RMP-designated lands with development constraints are not considered in this assessment but will be addressed by the CCFO during development of the RMP revision as well as during review and evaluation of individual permit applications. Technical, economic, and market factors are also not included in the assessment criteria because they reflect trends that are subject to change and, therefore, best left to developers and utilities as part of their planning analyses. However, at the end of this section there is a general overview of technical, regulatory, and economic factors that could influence solar energy development in the RMP planning area.

Existing Solar Energy Resources

The scope of this study is limited to utility-scale solar development on lands administered by the BLM within the RMP planning area. Commercially feasible utility-scale solar energy development requires adequate direct normal insolation (DNI) and large areas of land. NREL has developed a national solar resource assessment for the United States, which is updated periodically. The resource data for this assessment was generated in 2007, representing data from 1998 to 2005 (NREL, 2011f). The NREL studies display DNI in kilowatt-hours per square meter per day (KWh/m^2/day) on a scale from 3.0 KWh/m^2/day to over 9.0 KWh/m^2/day. NREL assessments and other studies generally identify DNI levels greater than or equal to 5 KWh/m2/day as the minimum threshold for feasible solar energy development.

Figure 2-4 shows Concentrated Collector solar resources on BLM lands in the planning area. The figure shows DNI in three levels ranging from 6.0 to 7.5, all above the generally accepted threshold of utility scale solar development. Table 2-8 summarizes the distribution of DNI for CSP development in the planning area.

Table 2-8: Concentrated Collector Solar Resources: Acres by Land Ownership

Direct Normal Solar Insolation (KWh/m^2/Day)	Land Ownership (Acres)						Total
	BLM	IR	NPS	Private	State	USFS	
3.0 - 6.0	-	-	-	-	-	-	0
6.0 - 6.5	190,393	-	-	101,201	28,391	201,631	521,615
6.5 - 7.0	1,779,858	2,503	8,851	795,724	262,539	112,650	2,962,126
7.0 - 7.5	134,721	-	-	80,580	15,603	40,047	270,951
7.5 - > 9.0	-		-	-	-	-	0
Total	2,104,972	2,503	8,851	977,506	306,533	354,327	3,754,692

Source: NREL and CCFO GIS data, 2011
BLM: Bureau of Land Management
IR: Indian Reservation
NPS: National Park Service
USFS: U.S. Forest Service

The table shows that BLM lands constitute 56 percent of lands with CSP solar resource potential in the planning area. A DNI of 6.0 or greater is consistent with the level of feasibility recommended in the UREZ Phase 1 report (USG, 2009a). A DNI of 6.5 or greater, which applies to 91 percent of BLM lands (51 percent of the planning area), is consistent with the feasibility thresholds recommended in the WREZ Phase 1 report (NREL, 2009) and the Draft PEIS for Solar Energy Development (DOE, 2010a).

Figure 2-5 shows Tilted PV Panel solar resources on BLM lands in the RMP planning area. The figure shows DNI in two levels: 5.5 – 6.0 and 6.0 – 6.5. Both are above the generally accepted threshold for utility scale solar development. Table 2-9 summarizes the distribution of DNI for PV development in the planning area.

Table 2-9: Tilted PV Panel Solar Resources: Acres by Land Ownership

Direct Normal Solar Insolation ($KWh/m^2/Day$)	Land Ownership (Acres)						TOTAL
	BLM	IR	NPS	Private	State	USFS	
3.0 - 5.5	-	-	-	-	-	-	0
5.5 - 6.0	736,425	-	5,995	332,883	115,710	314,279	1,505,291
6.0 - 6.5	1,368,547	2,503	2,856	644,623	190,823	40,049	2,249,401
6.5 - > 9.0	-	-	-	-	-	-	0
TOTAL	2,104,972	2,503	8,851	977,506	306,533	354,327	3,754,692

Source: NREL and CCFO GIS data, 2011
BLM: Bureau of Land Management
IR: Indian Reservation
NPS: National Park Service
USFS: U.S. Forest Service

Table 2-9 shows that BLM lands constitute 56 percent of all lands with PV solar resource potential in the planning area. A DNI of 6.0 or greater, which applies to 65 percent of BLM lands (36 percent of the planning area), is consistent with the level of feasibility recommended in the UREZ Phase 1 report (USG, 2009a).

Solar Energy Potential

Based on the NREL studies and other sources reviewed for this report, the criteria shown in Table 2-10 were used as qualitative indicators of solar energy potential in the planning area. These criteria were applied to the NREL solar DNI levels for both CSP and PV systems. In the table, DNI levels are grouped into one of three categories of resource potential (low, medium, and high). For this assessment, the 5 KWh/m2/day level is the threshold for “medium” solar resource potential. The results are shown in Figures 2-6 and 2-7. Figure 2-6 shows CSP resource potential, and Figure 2-7 shows Tilted PV Panel solar resource potential.

Table 2-11 summarizes the distribution of the three qualitative indicators of CSP potential by land ownership in the planning area.

Table 2-10: Solar Energy Assessment Criteria

Direct Normal Solar Insolation Level (KWh/m^2/Day)	Energy Potential
3.0 - 3.5	Low
3.5 - 4.0	
4.0 - 4.5	
4.5 - 5.0	
5.0 - 5.5	Medium
5.5 - 6.0	
6.0 - 6.5	
6.5 - 7.0	
7.0 - 7.5	High
7.5 - 8.0	
8.0 - 8.5	
8.5 - 9.0	
> 9.0	

Source: JBR, 2011

Table 2-11: Concentrated Collector Solar Potential: Acres by Land Ownership

Land Ownership	Solar Energy Potential (Acres)			Total
	Low	Medium	High	
Bureau of Land Management	-	1,970,251	134,721	2,104,972
Indian Reservation	-	2,503	-	2,503
National Park Service	-	8,851	-	8,851
Private	-	896,925	80,580	977,506
State	-	290,930	15,603	306,533
US Forest Service	-	314,280	40,047	354,327
Total	0	3,483,741	270,951	3,754,692

Source: JBR, 2011

Table 2-11 shows that 94 percent of BLM lands (52 percent of the planning area) have a medium potential (DNI from 5.0 - 7.0) and that the remaining 6 percent have a high potential (DNI > 7.0) for solar energy from concentrated collector systems. Table 2-12 summarizes the distribution of the three qualitative indicators of tilted PV panel solar energy potential by land ownership in the planning area. The table reflects the fact that all BLM lands in the planning area are designated as having a medium potential (DNI from 5.0 - 7.0) for solar energy from PV systems.

Table 2-12: Tilted PV Panel Solar Potential: Acres by Land Ownership

Land Ownership	Solar Energy Potential (Acres)			Total
	Low	Medium	High	
Bureau of Land Management	-	2,104,972	-	2,104,972
Indian Reservation	-	2,503	-	2,503
National Park Service	-	8,851	-	8,851
Private	-	977,506	-	977,506
State	-	306,533	-	306,533
US Forest Service	-	354,327	-	354,327
Total	0	3,754,692	0	3,754,692

Source: JBR, 2011

Power Capacity and Generation

Table 2-13 presents an estimate of the theoretical maximum energy generated by a concentrated collector solar system on BLM-administered lands assuming that all solar energy could be captured and converted to electrical energy. The estimate is based on NREL technical criteria of capacity factor and power density associated with each DNI level. The estimate does not reflect any reductions in the amount of potential solar energy that could be captured resulting from policy or regulatory "exclusion" or "avoidance" areas that may be applied during implementation of the RMP and review of ROW and other applications by the CCFO. Further, it doesn't reflect any reductions or adjustments in the amount of potential solar energy that could be captured resulting from technical, economic, or market constraints or limitations. Those factors are discussed in more detail in the section that follows. Based on NREL criteria, the table shows an estimated average annual capacity of 109,154 MW of concentrated collector solar energy on BLM lands. When annual capacity is converted to generation, BLM lands represent in excess of 956 million MWh.

Table 2-13: Potential Annual Capacity and Generation From Concentrated Collector Solar Energy Systems on BLM Lands

DNI ($KWh/m^2/day$)	Capacity Factor[1]	Power Density (MW/km^2)	Square Kilometers	Average Annual Capacity (MW)[3]	Potential Average Annual Generation (MWh)[4]
6.0 - 6.5	0.31555	32.985	771	8,020	70,254,308
6.5 - 7.0	0.393247	32.985	7,203	93,433	818,473,405
7.0 - 7.5	0.428193	32.985	545	7,701	67,457,254
Total			8,519	109,154	956,184,967

Source: NREL, 2011
[1] Percentage of time power is being generated
[2] Measured in MW per square kilometer
[3] = Capacity Factor x Power Density x Square Kilometers
[4] = Average Annual Capacity x 8,760 hours/year

Table 2-14 presents an estimate of the maximum energy that could be generated by a tilted PV panel solar system on BLM-administered lands assuming that all solar energy could be captured and converted to electrical energy. The estimate is based on NREL technical criteria of capacity factor and power density associated with each DNI level. The estimate does not reflect any reductions in potential solar energy that could be captured resulting from policy or regulatory "exclusion" or "avoidance" areas or from technical, economic, or market constraints or limitations. Those factors are discussed in more detail in the section that follows. Based on NREL criteria, the table shows an estimated average annual capacity of 101,328 MW of solar energy from PV systems on BLM lands. When annual capacity is converted to generation, BLM lands represent 887,636,920 MWh.

Table 2-14: Potential Annual Capacity and Generation From Tilted PV Panel Solar Energy Systems on BLM Lands

DNI ($KWh/m^2/day$)	Capacity Factor[1]	Power Density (MW/km^2)	Square Kilometers	Average Annual Capacity (MW)[3]	Average Annual Generation (MWh)[4]
5.5 - 6.0	0.247621681	48.00	2,983	35,450	310,540,006
6.0 - 6.5	0. 247621681	48.00	5,543	65,879	577,096,913
Total			8,525	101,328	887,636,920

Source: NREL, 2011
[1] Percentage of time power is being generated
[2] Measured in MW per square kilometer
[3] = Capacity Factor x Power Density x Square Kilometers
[4] = Average Annual Capacity x 8,760 hours/year

Factors Affecting Resource Development Potential

This report focuses on the resource-level potential for solar energy development. The scope of the study is limited to baseline screening criteria most commonly used by the solar energy industry and federal agencies involved in the ongoing study of solar energy and resource development, such as NREL and DOE. However, there are numerous other factors that can significantly affect the viability of solar energy development in any given locale. Those additional factors can be generally described in one of two broad categories: (1) policy and regulatory and (2) economic and technical. The most common factors in each of these categories are summarized below.

Policy and Regulatory Factors

Policy and regulatory factors are those that involve regulation, management, and administration of BLM lands within the RMP planning area and which may affect the location, size, configuration, and operation of a solar energy facility. Many of the NREL and other recent studies apply some level of screening using "exclusion" and "avoidance" criteria. In particular, the *Solar Energy Draft PEIS* and *Western Renewable Energy Zone (WREZ) Initiative Phase 1 Report* apply a significant number of screening criteria reflecting potential constraints to renewable energy development imposed by policies and regulations.

Most recently the BLM issued *IM 2011-061 Solar and Wind Applications, Pre-Application and Screening* (February 2011). The IM contains a screening process designed to direct development away from lands with high use conflict or sensitive resource values and toward low conflict areas such as previously disturbed sites, areas adjacent to previously disturbed or developed sites, and locations that minimize construction of new roads and/or transmission lines. Applications in high conflict areas will be more difficult to process and require a greater level of consultation, analysis, and mitigation to resolve issues. Applications with fewer resource conflicts are anticipated to be easier and less costly and time-consuming for BLM to process. Projects that avoid impacts to specially designated areas will be given a higher

priority for processing. Consistent with IM 2011-061, the BLM will use the following screening criteria to assist in the processing of solar energy development ROW applications.

Low Potential for Conflict – timely or expedited authorizations possible:

- Lands specifically identified for solar or wind energy development in BLM land use plans.
- Previously disturbed sites or areas adjacent to previously disturbed or developed sites.
- Locations that minimize construction of new roads and/or transmission lines.
- Lands adjacent to designated transmission corridors.
- Lands currently designated as Visual Resource Management Class IV.
- Lands identified as suitable for disposal in BLM land use plans.

Medium Potential for Conflict – projects that have resource conflicts that can potentially be resolved:

- Designated BLM special management areas, including ACEC areas.
- Lands with wilderness characteristics outside Wilderness and Wilderness Study Areas.
- Right-of-way avoidance areas.
- Areas listed in the National Register of Historic Places or other sensitive areas such as National Natural Landmarks and National Historic Landmarks.
- Areas with National Historic and Scenic Trails and National Recreation Trails.
- Sensitive habitat areas, or areas of importance for federal or state sensitive species.
- Lands currently designated as Visual Resource Management Class III.
- DOD operating areas, including significant radar, airspace, or land use conflicts.
- Areas where project development may adversely affect lands acquired for conservation purposes.
- Developed recreation sites and/or facilities.
- Projects with proposed groundwater uses within groundwater basins that have been over-appropriated by state water resource agencies.

High Potential for Conflict – more complex projects that will require a greater level of consultation, analysis, and mitigation to resolve issues or may not be feasible to authorize:

- Lands near or adjacent to units of the National Park System, Fish and Wildlife Service Refuge System, National Forest System, and BLM National Landscape Conservation System.
- Lands adjacent to Wild, Scenic, and Recreational Rivers and river segments determined eligible/suitable for Wild or Scenic River status.
- Designated critical habitat for federally threatened and/or endangered species.
- Lands currently designated as Visual Resource Management Class I or Class II.
- Right-of-way exclusion areas.
- Lands currently designated as NSO in BLM land use plan prescriptions.

Economic and Technical Factors

Following are examples of technical and economic factors that may affect the siting and development of solar energy projects. The examples are from various NREL solar assessments and the *UREZ Phase 1 and 2* studies and will vary with each individual project.

- Distance and access to existing or proposed transmission lines or corridors (e.g., within 50 miles).
- Available electric transmission capacity (e.g., 115-345 kV).

- Natural gas pipeline within 25 miles.
- Access and distance to roads and highways (e.g., 50 miles).
- Proximity to urban area for operations and maintenance (e.g., within 100 miles).
- Slope of land area (e.g., doesn't exceed 5 percent).
- Site must allow structures 15 – 50 feet high.
- Average wind speed at site < 10 mph.
- Minimum parcel size of 40 contiguous acres.
- Available water supply.
- Renewable energy financial incentives from federal or state governments (e.g., federal and State of Utah production tax credits).
- Cost of generation (including operations and maintenance, equity investment in capital, financing, and taxes).
- Transmission interconnection costs.

Figure 2-4 Concentrated Collector Solar Resources

Bureau of Land Management
Cedar City Field Office

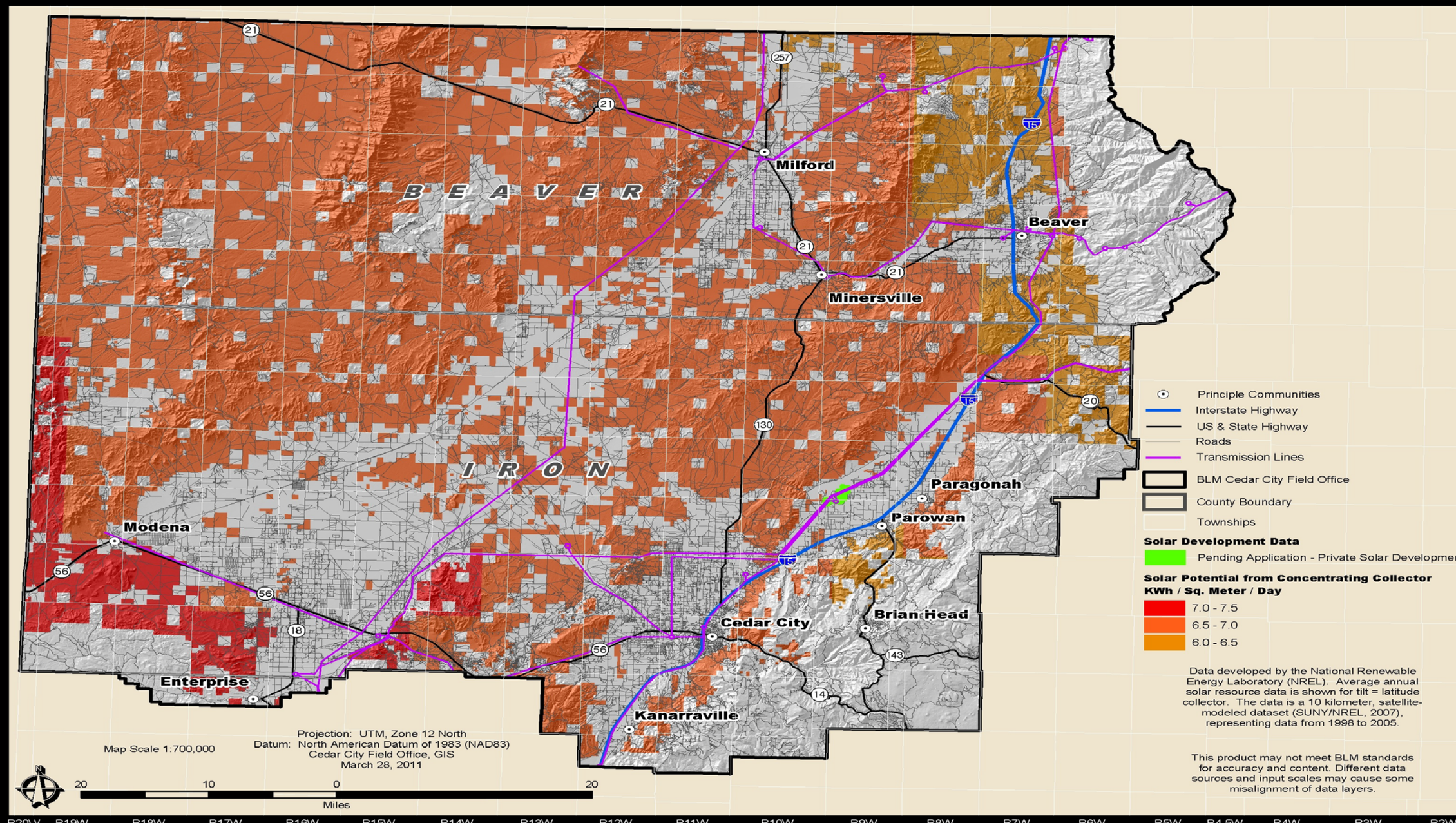

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Figure 2-5 Tilted Photovoltaic Panel Solar Resources

Bureau of Land Management
Cedar City Field Office

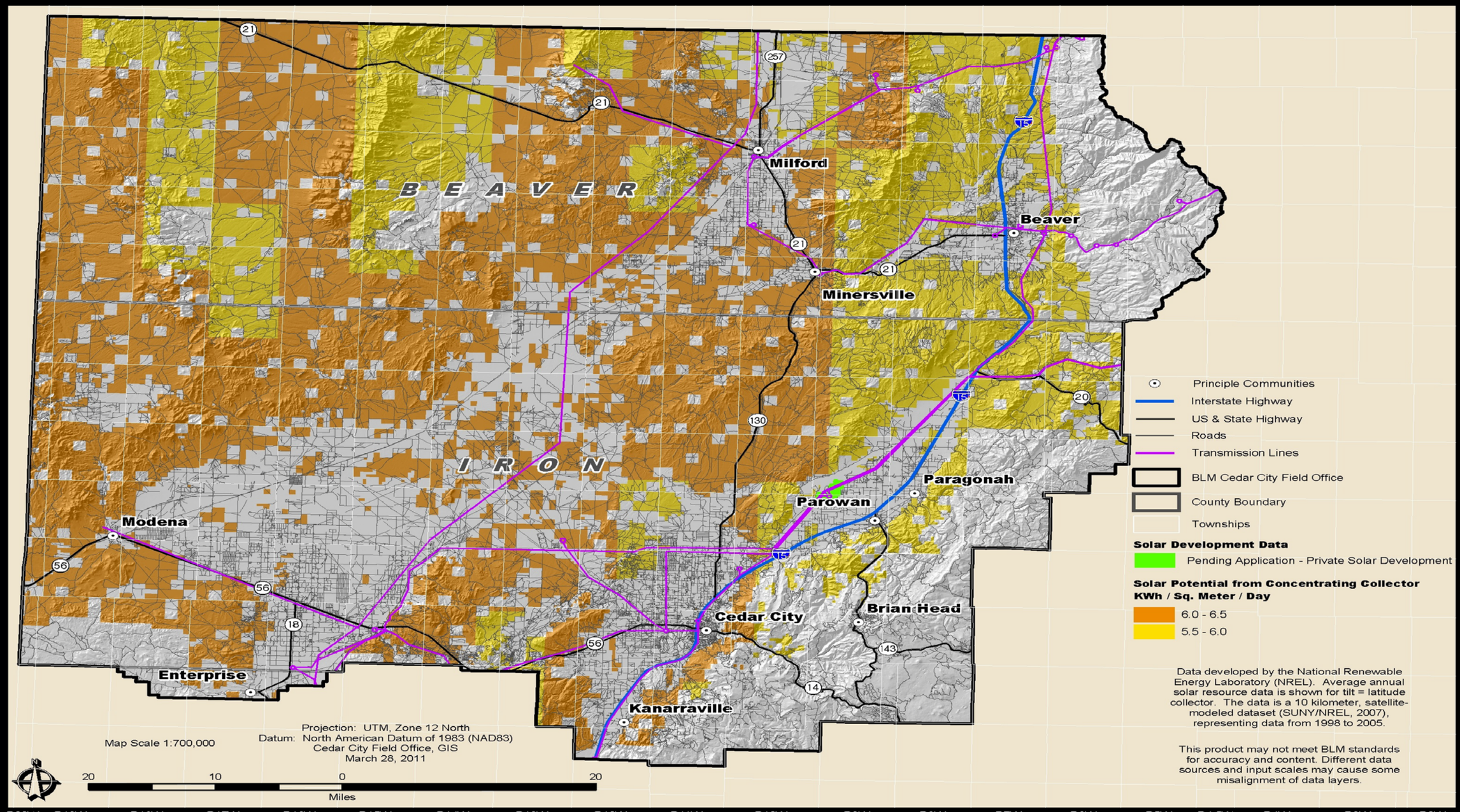

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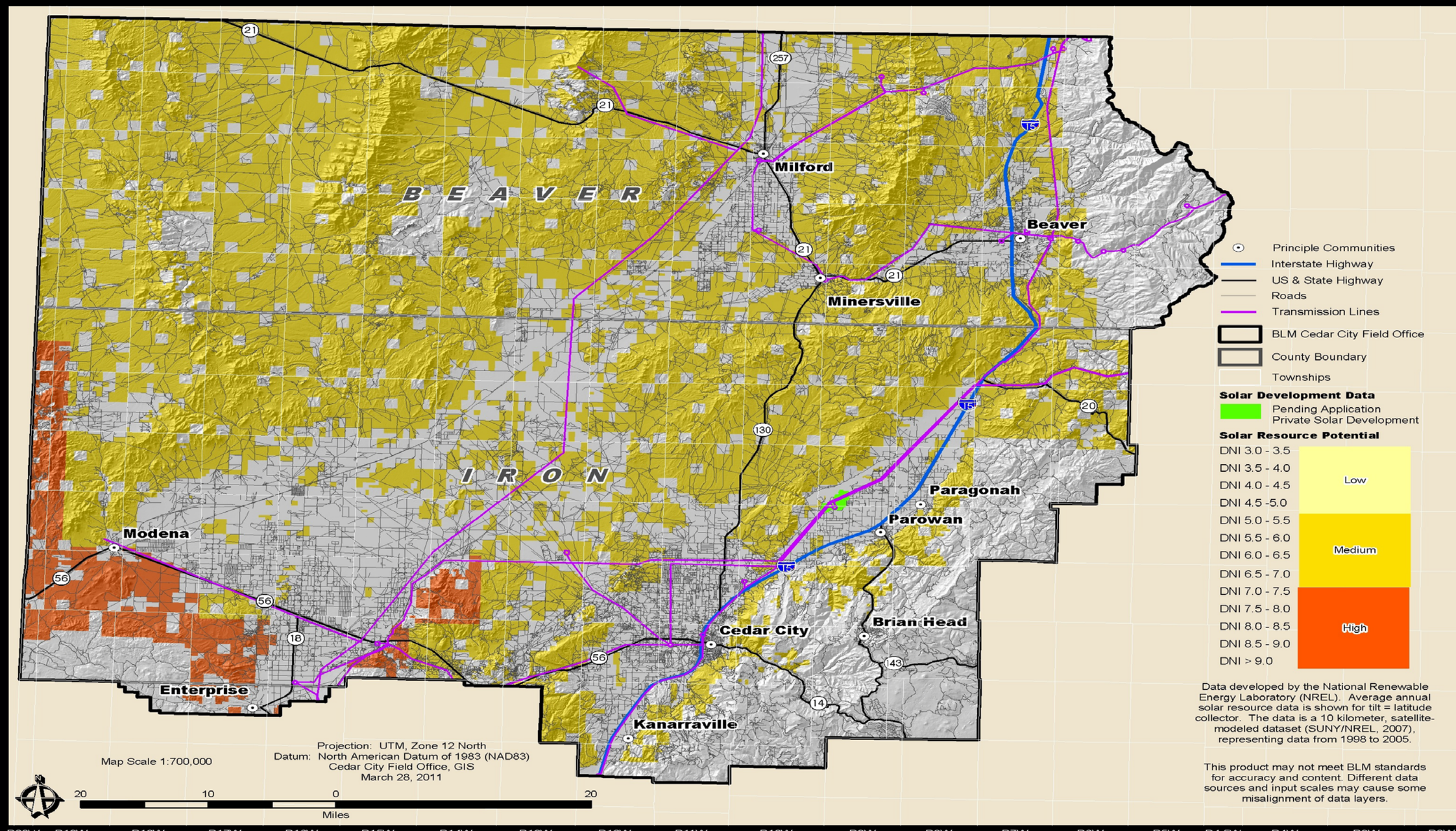
Figure 2-6 Concentrated Collector Solar Resource Potential

Bureau of Land Management
Cedar City Field Office



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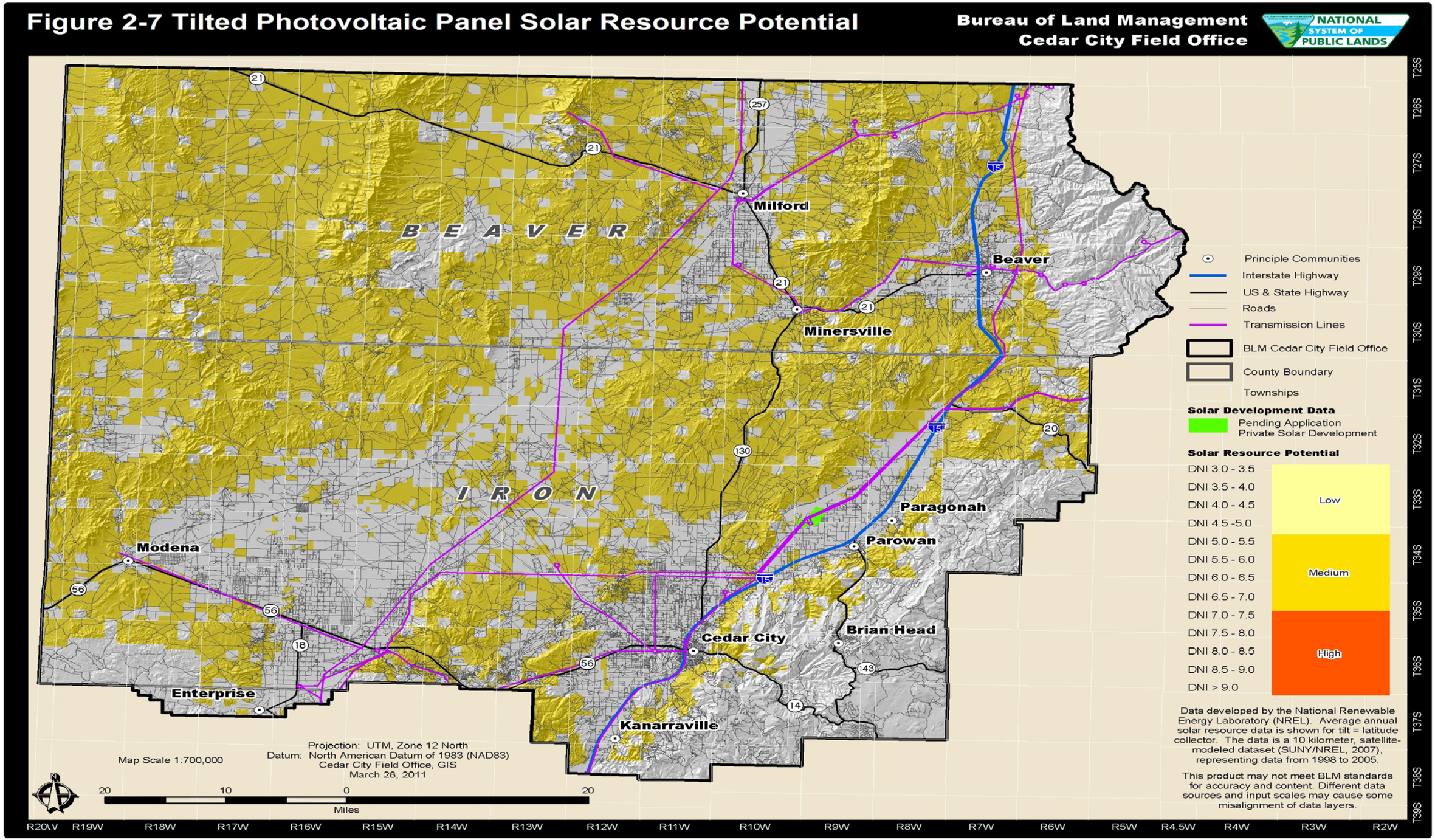
Figure 2-7 Tilted Photovoltaic Panel Solar Resource Potential
Bureau of Land Management
Cedar City Field Office
NATIONAL SYSTEM OF PUBLIC LANDS
B E A V E R
I R O N
Milford
Beaver
Minersville
Modena
Paragonah
Parowan
Cedar City
Brian Head
Enterprise
Kanarraville
Principle Communities
Interstate Highway
US & State Highway
Roads
Transmission Lines
BLM Cedar City Field Office
County Boundary
Townships
Solar Development Data
Pending Application
Private Solar Development
Solar Resource Potential
DNI 3.0 - 3.5
DNI 3.5 - 4.0
DNI 4.0 - 4.5
DNI 4.5 -5.0
DNI 5.0 - 5.5
DNI 5.5 - 6.0
DNI 6.0 - 6.5
DNI 6.5 - 7.0
DNI 7.0 - 7.5
DNI 7.5 - 8.0
DNI 8.0 - 8.5
DNI 8.5 - 9.0
DNI > 9.0
Low
Medium
High
Data developed by the National Renewable Energy Laboratory (NREL). Average annual solar resource data is shown for tilt = latitude collector. The data is a 10 kilometer, satellite-modeled dataset (SUNY/NREL, 2007), representing data from 1998 to 2005.
This product may not meet BLM standards for accuracy and content. Different data sources and input scales may cause some misalignment of data layers.
Map Scale 1:700,000
Projection: UTM, Zone 12 North
Datum: North American Datum of 1983 (NAD83)
Cedar City Field Office, GIS
March 28, 2011
20 10 0 20
Miles
T25S T26S T27S T28S T29S T30S T31S T32S T33S T34S T35S T36S T37S T38S T39S
R20W R19W R18W R17W R16W R15W R14W R13W R12W R11W R10W R9W R8W R7W R6W R5W R4.5W R4W R3W R2W

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2.4 Biomass Energy

Overview

Bioenergy, or biomass power, is the use of biomass to generate electricity. Wood is still the largest biomass energy resource. However, other sources of biomass can also be used including food crops, grassy and woody plants, residues from agriculture or forestry, oil-rich algae, and the organic component of animal, municipal, and industrial wastes (NREL, 2010). The most common technique for generating power is the use of direct-fired systems, which burn bioenergy feedstocks directly to produce steam. This steam drives a turbine, which turns a generator that converts the power into electricity.

The BLM manages approximately 65 million acres of forests and woodlands in 14 western states and Alaska. It is estimated that 16 million acres are in need of restoration. Restoration consists primarily of thinning and clearing overstocked forest and woodland stands to improve wildlife habitat, increase forest and rangeland health, and reduce the risks of wildfire. The by-product of thinning and clearing is biomass. Woody biomass is primarily composed of restoration residues and smaller diameter trees and brush from forestry, fuels, and rangeland treatments. Use of biomass from BLM-administered lands is expected to increase as new bioenergy facilities continue to come on-line (BLM, 2011a).

Figure 2-8 shows forested and non-forested vegetative cover within the RMP planning area. Not all vegetative types have the potential for bioenergy production. In the planning area, the dominant forested species are the Great Basin and Colorado Plateau pinyon-juniper. Within the planning area, these species are the primary source of woody biomass with the potential for energy production.

Existing and Pending Development

BLM-Administered Lands

Biomass projects on BLM-administered lands are associated with stewardship contracts. The stewardship program allows the BLM to enter into long-term contracts with local small business, communities, and non-profit organizations to thin forested areas specified in the contract to improve forest, woodland, and rangeland health; improve fish and wildlife habitat; and reduce the risk of wildfires. Table 2-15 summarizes existing and pending stewardship contracts on BLM lands. Active and pending contracts are also shown in Figure 2-8.

Active Projects As of February 2011, the BLM Cedar City FO had three active stewardship contracts in place related to biomass for a total of 1,058 acres. Two other contracts have defaulted, and two previous contracts have been completed. The three active stewardship contracts are described below and summarized in Table 2-15.

- Atchison: The Atchison contracts are a series of small stewardship contracts in the Indian Peak range west of Cedar City. Collectively these contracts (including completed, defaulted, and active) will treat approximately 470 acres by thinning pinyon-juniper woodlands in one of the CCFO's primary commercial pine nut areas.

- Nevershine Stewardship: The Nevershine Stewardship is a small contract developed from a fuels/wildlife habitat project and is a pinyon-juniper woodlands thinning project for forest health, wildlife habitat, and fuels reduction. The project is a clear-cut with a few residual trees on 135 acres.

- Nevershine Hollow Stewardship: The Nevershine Hollow Stewardship is a multi-year contract that may have smaller contracts awarded through 2013. To date, 731 acres have been awarded.

Table 2-15: Existing and Pending Stewardship Contracts

Project Name	Acres	Tons	Award Year
Existing Contracts			
Atchison 2007	78	585	2007
Atchison 2009	82	2115	2009
Atchison Christmas Trees	34	34	2008
Nevershine	135	810	2008
Nevershine Hollow MLR TO1	203	1110	2009
Nevershine Hollow ARRA TO2	155	850	2009
Nevershine Hollow ARRA TO3	371	2040	2010
Pending Contracts			
Atchison Reoffer	119	890	2012
Nevershine Hollow MLR TO4	190	1045	2012
Blawn Mountain	4500	18000	2012
Paradise Mountains	3000	18000	2013-2014

Source: Doug Page, BLM Southwest Utah Zone Forester, and CCFO GIS data, 2011

Pending Projects As of March 2011, the BLM CCFO had four pending stewardship projects being processed. They include the Atchison Reoffer project, Nevershine Hollow MLR TO4, the Blawn Mountain project, and the Paradise Mountains project (BLM, 2011b).

Private Lands

Active Projects There are currently no operating biomass projects on private lands within the RMP planning area.

Pending Projects In the Milford area, the Circle Four Farms is considering installation of biogas generating facilities. The facilities would convert hog waste to electricity from biogas derived from anaerobic digestion and gasification of the waste. Two separate generating stations of 2.5 MW each are being planned.

Assessment of Biomass Resource Potential

This section presents the results of a baseline resource-level assessment of biomass resources in the RMP planning area. Accordingly, its focus is on factors such as geographic distribution and location, topography, vegetative cover type, and overall potential for biomass energy. Regulatory and policy factors such as wilderness areas, critical habitat, and other land management constraints will be addressed by the CCFO during review and evaluation of individual projects as it implements the updated RMP. Technical, economic, and market factors are also not included in the assessment criteria because they reflect trends that are subject to fluctuation and, therefore, best left to land managers and project developers as part of their planning analyses. However, at the end of this section there is a general overview of technical and economic factors that could influence biomass energy development in the RMP planning area.

Existing Biomass Resources

Beaver and Iron Counties comprise the vast majority of the RMP planning area, along with a small portion of Washington County. Because the area within Washington County contains little or no forested areas, biomass data and mapping were limited to Beaver and Iron Counties.

The assessment of biomass energy potential utilized the USDA Forest Service's Forest Inventory and Analysis (FIA) National Program. The program consists of three phases. The first phase utilizes remote sensing data to classify forested and non-forested lands. In the second phase, field sample sites are selected in the survey area based on approximately one sample site for every 6,000 acres. The sampling sites are surveyed by field crews that collect a variety of forest ecosystem data. Non-forested areas are also surveyed as necessary to quantify rates of land use change. In the third phase, additional sampling sites are selected at approximately one in every 96,000 acres. These sites are surveyed during the growing season to collect data on vegetation, lichen, tree crown condition, soils, coarse woody debris, and ozone damage (USFS, 2010).

Figure 2-8 shows vegetative cover types on all land ownerships within the planning area based on FIA spatial data. Although all of the vegetative cover types shown in Figure 2-8 were included in this assessment, not all biomass is usable for bioenergy purposes. Actual biomass yield is discussed below.

Figure 2-9 shows the distribution of existing biomass resources on BLM-administered lands in the planning area expressed in potential tons per acre of biomass yield. Potential yield ranges from less than 12 tons/acre to more than 44 tons/acre. Table 2-16 summarizes the distribution of potential biomass yield by land ownership within the planning area, including the 2,104,972 acres of BLM-administered lands. The table shows that 74.8 percent (1,574,890 acres) of BLM lands in the planning area have a biomass yield of less than 12 TPA, and less than 1 percent (410 acres) have a biomass yield of more than 44 TPA. Biomass yields on the remaining 25 percent (529,671 acres range from 12 to 44 TPA.

Table 2-16: Existing Biomass Resources by Land Ownership

Land Ownership	Acres by Biomass Volume (Tons/Ac.)					Total
	< 12	12 - 19	20 - 31	32 - 44	> 44	
Bureau of Land Management	1,574,890	449,044	73,896	6,731	410	2,104,972
Indian Reservation	2,472	31	-	-	-	2,503
National Park Service	4,610	2,561	1,189	388	102	8,851
Private	862,383	50,977	37,384	21,302	5,459	977,506
State	217,361	52,995	12,582	2,320	714	285,972
State Parks and Recreation	506	-	-	-	-	506
State Wildlife Reserve/Mgt Area	6,985	9,646	3,113	267	44	20,055
US Forest Service	66,494	75,473	83,984	80,337	40,970	347,258
USFS Wilderness Area	459	732	2,161	2,784	933	7,069
Total	2,736,159	641,460	214,309	114,130	48,633	3,754,692

Source: Doug Page, BLM Southwest Utah Zone Forester, and CCFO GIS data, 2011

Assessment of Biomass Potential

Figure 2-10 shows biomass resource potential in the planning area based on tons per acre of biomass yield. The five categories of biomass yield presented in Table 2-16 were further screened and combined to identify areas with low, medium, and high potential. The criteria for this indicator of biomass potential are shown in Table 2-17.

Table 2-17: Biomass Energy Potential Criteria

Biomass Resource (Tons/Ac)	Biomass Energy Potential
0 - 5 tons/ac	Low
5 - 20 tons/ac	Medium
> 20 tons/ac	High

Source: Doug Page, BLM Southwest Utah Zone Forester, 2011

Table 2-18 shows how biomass energy potential, based on these criteria, are distributed throughout the planning area based on land ownership. The table shows that 51.8 percent (1,090,308 acres) of BLM lands in the planning area have low potential for biomass energy, 44.4 percent (933,626 acres) have medium potential, and the remaining 3.8 percent (81,038 acres) have high potential for biomass energy.

Table 2-18: Biomass Energy Potential by Land Ownership

Land Ownership	Biomass Energy Potential (Acres)			Total
	Low	Medium	High	
Bureau of Land Management	1,090,308	933,626	81,038	2,104,972
Indian Reservation	783	1,720	-	2,503
National Park Service	3,247	3,924	1,680	8,851
Private	815,027	98,333	64,146	977,506
State	162,304	108,052	15,616	285,972
State Parks and Recreation	504	2	-	506
State Wildlife Reserve/Mgt Area	-	-	-	0
US Forest Service	-	-	-	0
USFS Wilderness Area	-	-	-	0
Total	2,072,173	1,145,656	162,480	3,380,310

Source: Doug Page, BLM Southwest Utah Zone Forester, JBR 2011

Estimated Power Capacity

Fuels thinning and habitat enhancement projects within the planning area have been shown to yield approximately 5.5-6 green tons of biomass per acre with an additional 2 tons/acre available if an area were to be clear-cut (BLM, 2011b). Because typical moisture content of harvested wood is 50 percent, 1 green ton of biomass would equal 1 bone dry ton (BDT). Based on these values, 1 treated acre within the CCFO yields approximately 3-5 BDT of biomass. Based on this content and yield, there is an estimated maximum 6,314,916 - 10,524,860 BDT of woody biomass within the planning area on BLM-administered lands. Based on the assumption that 8,000 BDTs are consumed to produce 1 MW of power, the total woody biomass could produce 789 - 1,315 MW of power. Potential biomass energy could be substantially less depending on stand density and the limiting factors discussed below.

Factors Affecting Resource Development Potential

This report focuses on the resource-level potential for biomass energy development. The scope of the study was limited to review of existing studies and materials as well as GIS analysis. Factors affecting resource development potential can be described in one of two broad categories: (1) policy and regulatory and (2) economic and technical. The most common factors in each of these categories are summarized below. In addition to the factors addressed below, a wide array of social issues may affect project development.

Policy and Regulatory Factors

Policy and regulatory factors are those that involve regulation, management, and administration of BLM lands within the RMP planning area and which may affect the location, size, configuration, and operation of biomass projects and facilities. Based on other renewable energy studies, these factors can generally be described as areas for either “Exclusion” or “Avoidance” (WREZ, 2009). These factors will generally be applied during BLM review of development applications as it implements the updated RMP.

- ***Exclusion*** areas are those where development is already precluded by statute or regulation (federal, state, local). Examples that apply to BLM-administered lands include Areas of Critical Environmental Concern, National Landscape Conservation units, National Monuments, Wilderness Study Areas, and designated Wilderness Areas.

- ***Avoidance*** areas are those that should be avoided because of purpose, policy, or restrictions. Examples that apply to BLM-administered lands include ACECs for solar or wind development; Class I and II Visual Resource Management areas; Military Operating Areas; and RMP-designated lands with constraints such as seasonal restrictions, ROW avoidance areas, Special Recreation Management Areas, Off-Highway Vehicle (OHV) open areas, NSO Areas, Research Natural Areas, and Wildlife Management Areas.

Economic and Technical Factors

Following are examples of technical and economic factors that may affect the siting and development of biomass projects. These factors are very site specific and will vary with each individual project.

- *Bioenergy Facility Development:* Although existing power generation or heating facilities may be capable of converting biomass to energy, they are often grossly inefficient and in need of major retrofitting. The development of new facilities that are both efficient and readily available is currently a major limiting factor in the development of biomass projects.

- *Haulage Distances:* Pinyon-juniper woodlands are often located in remote areas where transportation costs make hauling the biomass impractical.

- *Terrain Slope:* Pinyon-juniper woodlands are often located on steep slopes. Most mechanical treatment and extraction processes are limited to slopes less than 30 percent.

- *Soil Compaction and Erosion:* Certain pinyon-juniper woodlands occur on soils that are susceptible to compaction and erosion. Mechanical operations are subject to treatment windows where soils are dry and stable.
- *Ecological Response:* Pinyon-juniper woodlands that have become overstocked may be less suitable for treatment because the understory may be sparse or non-existent. Projects where an understory response is more likely and the potential for nutrient loss and non-native invasion is lower may be given priority over stands with more available biomass.

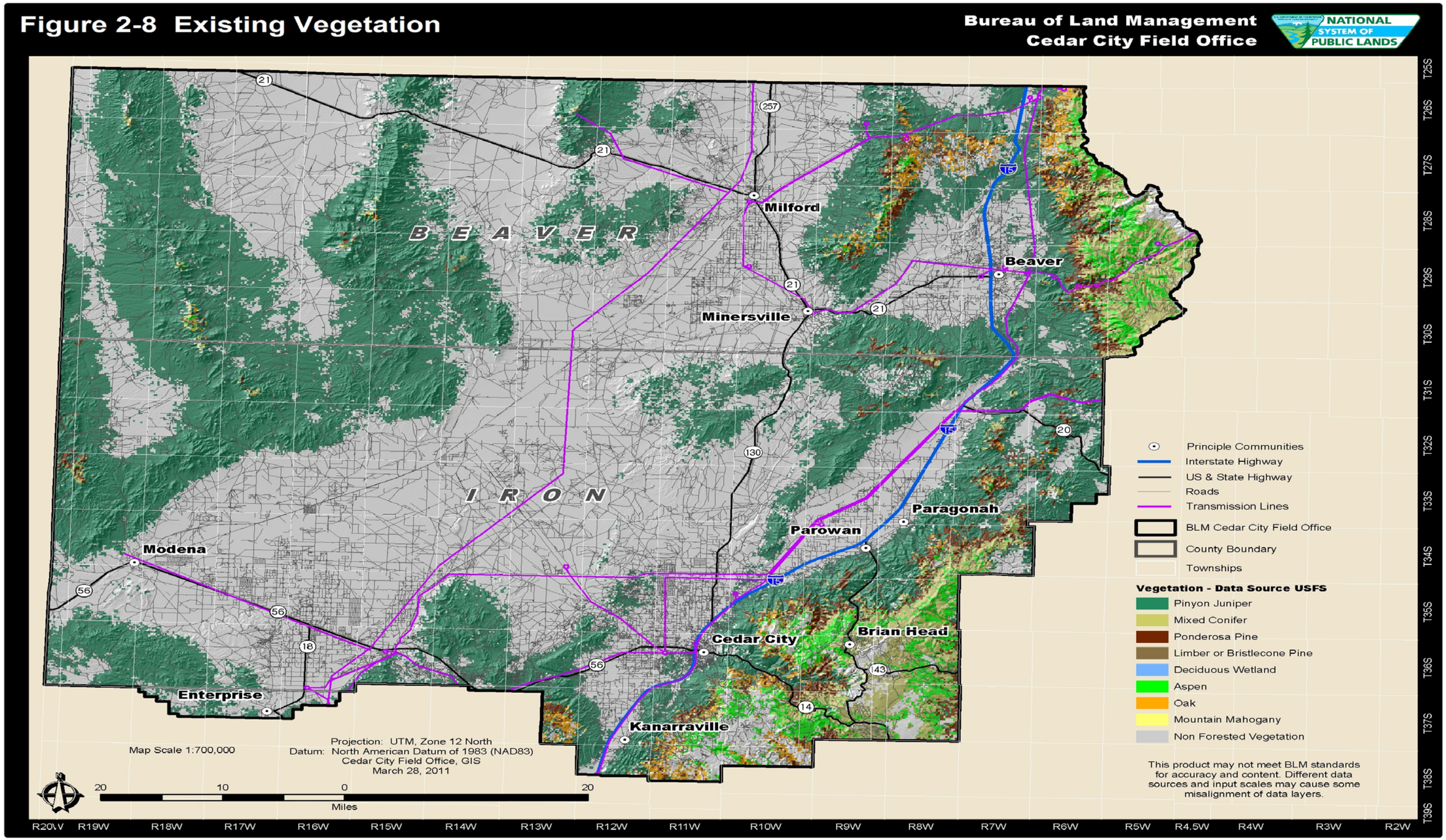
Figure 2-8 Existing Vegetation
Bureau of Land Management
Cedar City Field Office
NATIONAL SYSTEM OF PUBLIC LANDS
B E A V E R
I R O N
Milford
Beaver
Minersville
Paragonah
Parowan
Modena
Cedar City
Brian Head
Enterprise
Kanarraville
Principle Communities
Interstate Highway
US & State Highway
Roads
Transmission Lines
BLM Cedar City Field Office
County Boundary
Townships
Vegetation - Data Source USFS
Pinyon Juniper
Mixed Conifer
Ponderosa Pine
Limber or Bristlecone Pine
Deciduous Wetland
Aspen
Oak
Mountain Mahogany
Non Forested Vegetation
This product may not meet BLM standards for accuracy and content. Different data sources and input scales may cause some misalignment of data layers.
Map Scale 1:700,000
Projection: UTM, Zone 12 North
Datum: North American Datum of 1983 (NAD83)
Cedar City Field Office, GIS
March 28, 2011
20 10 0 20
Miles
T25S T26S T27S T28S T29S T30S T31S T32S T33S T34S T35S T36S T37S T38S T39S
R20W R19W R18W R17W R16W R15W R14W R13W R12W R11W R10W R9W R8W R7W R6W R5W R4.5W R4W R3W R2W

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Figure 2-9 Existing Biomass Resources

Bureau of Land Management
Cedar City Field Office

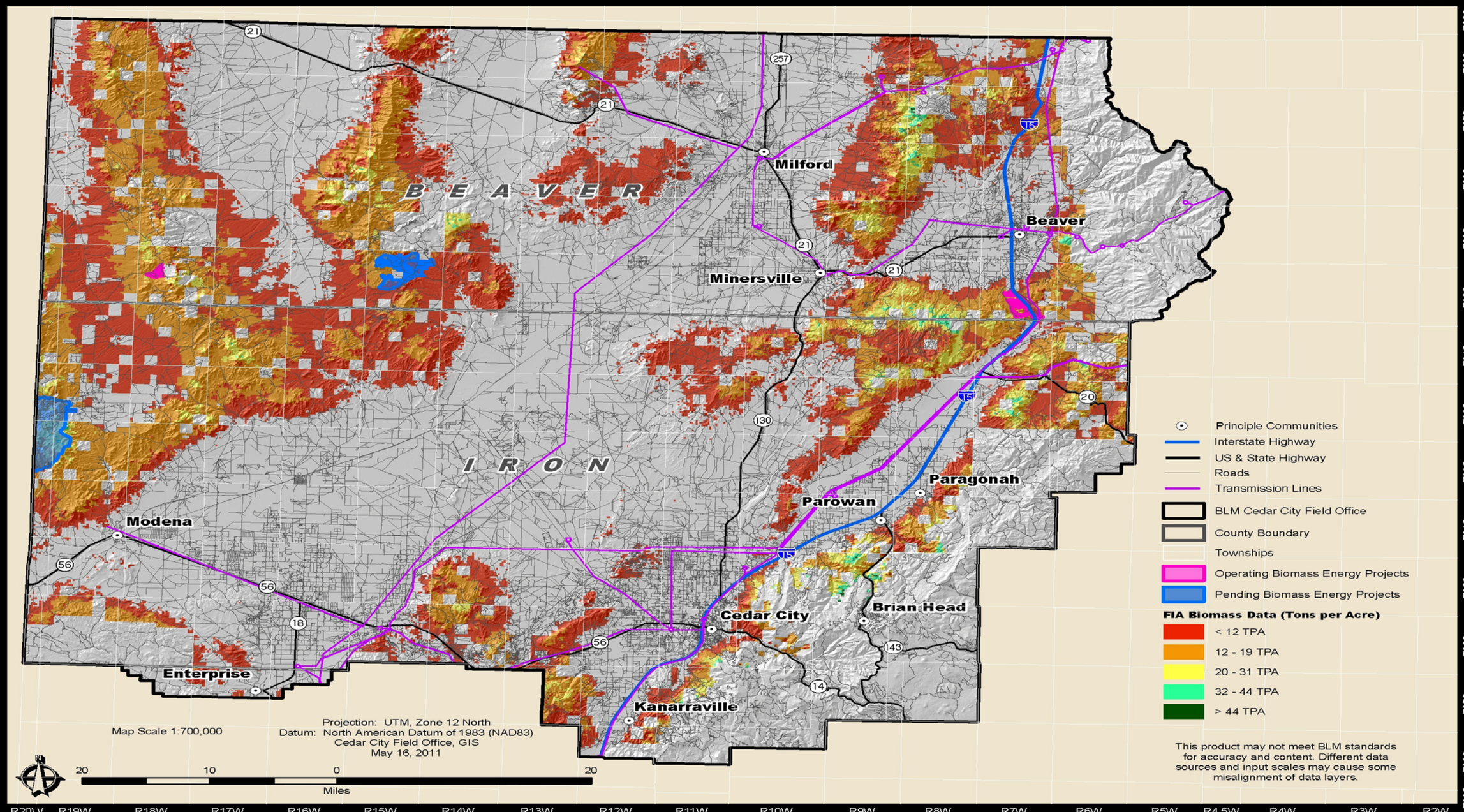

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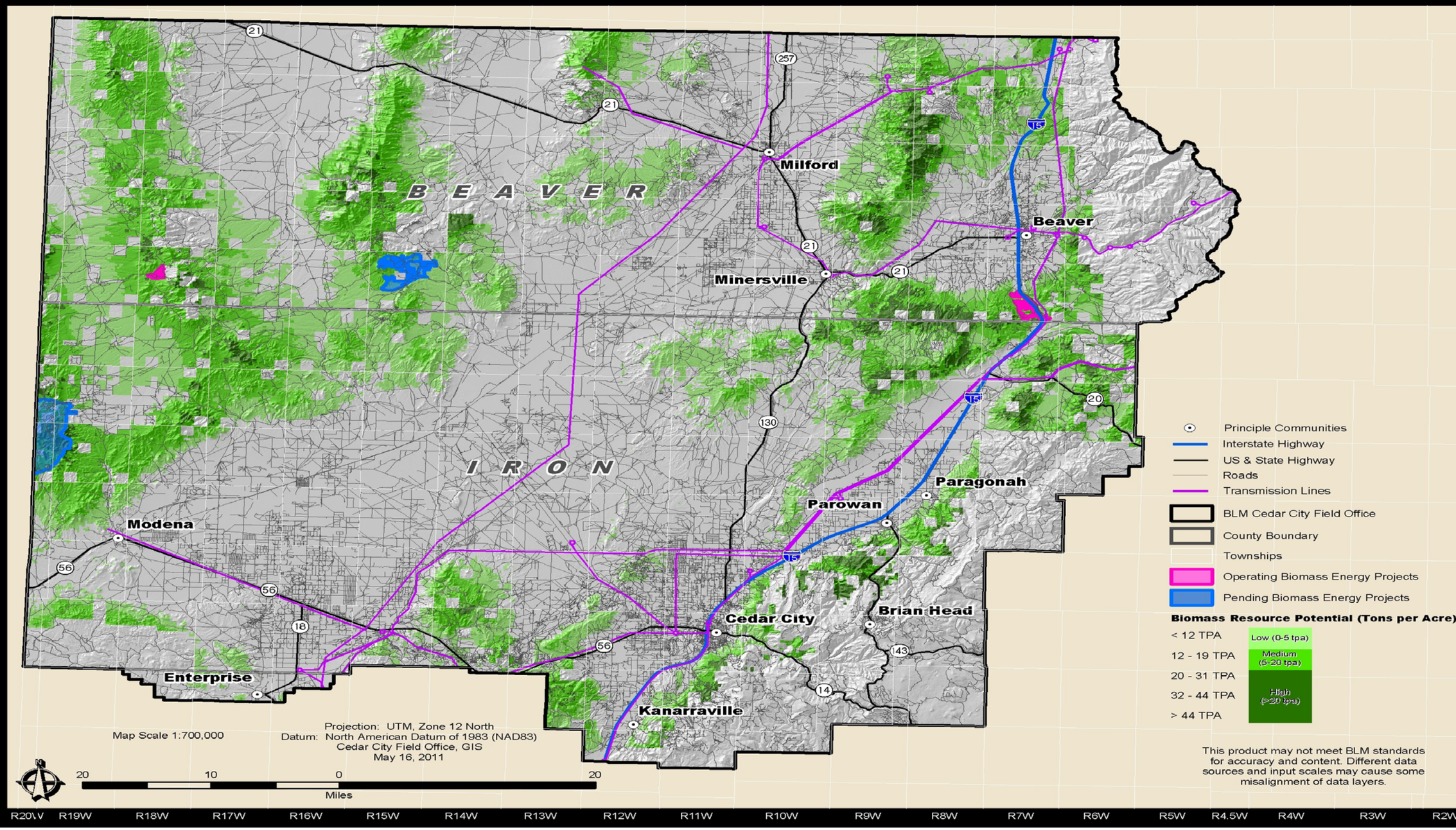
Figure 2-10 Biomass Resource Potential

Bureau of Land Management
Cedar City Field Office



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CONTACTS AND SOURCES OF DATA

3.1 Sources of Maps and Data

All Renewable Energy Resources

In addition to the studies identified above, this report relied on a number of sources for data and maps on renewable energy resources, pending permits for facilities, and approved or operating facilities in the CCFO. The following sources contributed to all of the renewable energy resources in this report. Sources specific to wind, solar, biomass, or geothermal resources are listed separately below.

- Beaver County Planning Department
- Iron County Planning Department
- NREL website
- NREL Renewable Resource Data Center
- State of Utah Automated Geographic Reference Center (AGRC)
- Utah Geological Survey (UGS) Renewable Energy Zone Task Force website
- Western Governors' Association, Western Renewable Energy Zones website
- BLM LR2000 website

Wind Energy

- U.S. DOE, Federal Wind Siting Information Center website
- U.S. DOE, Wind Powering America website
- NREL Wind Research website
- NREL Headquarters, Golden, Colorado
- Pacific Northwest Laboratories, Richland, Washington
- American Wind Energy Association website
- AWS Truepower website
- BLM Wind Energy website
- BLM Wind Energy Programmatic EIS Information website
- BLM Utah Wind Energy website
- Utah Geological Survey Wind Energy Program website
- Northwest Sustainable Energy for Economic Development (NWSEED) website

Solar Energy

- BLM Solar Energy website
- Argonne National Laboratories Solar Energy Development Programmatic EIS website
- U.S. DOE Solar Energy website
- NREL Solar Energy website

Biomass Energy

- NOAA Satellite and Information Service: Global Vegetation Index Products
- Coordinated Resource Offering Protocol (CROP) website
- Utah CROP website

- NREL Biomass website

Geothermal Energy

[To be completed pending receipt of the Mineral Potential Report]

3.2 Agency Contacts

All Renewable Energy Resources

In addition to the many contributing staff at the CCFO, consultant team contacted and/or met with the following individuals:

- James R. Gazewood, Renewable Energy Coordinator, BLM Utah State Office
- Bert Granberg, State of Utah Automated Geographic Reference Center (AGRC)
- Mary Ann Wright, Energy Resource Coordinator, Office of the Governor, State of Utah
- Ronald W. Daniels, Energy Policy Coordinator, Office of the Governor, State of Utah
- Elise Brown, former Renewable Energy Coordinator, Utah State Energy Program, Utah Geological Survey
- Todd Stowell, AICP, Iron County Community Planner
- Bill Nelson, Iron County GIS Technician
- Scott Albrecht, Beaver County Commission

Biomass Energy

Aaron Wilkerson, BLM Utah State Office

Geothermal Energy

[To be completed pending receipt of the Mineral Potential Report]

3.3 Industry Contacts

In February of 2011, the CCFO sent a letter to energy companies and utilities that have been active in energy development within the planning area. The letter summarized the intent of the renewable energy potential study and asked recipients for any available information on existing or potential resources (solar, wind, geothermal, or biomass) or development opportunities within the CCFO planning area. Of the 17 companies and utilities contacted, responses were received from 4. Companies and utilities contacted by the CCFO are listed below.

Wind

- Energy Unlimited, Inc.
- Evergreen Wind Power Partners LLC
- Wasatch Wind Development LLC
- Ridgeline Energy LLC
- Mormon Mesa Power Partners LLC
- Milford Wind Corridor LLC

- First Wind
- Renewable Energies LLC

Biomass

- Mark Spencer
- Prime Point, LLC
- Bloomin Ranch Service LLC

Geothermal

- Raser Technologies
- PacifiCorp
- ENEL North America

Utilities

- PacifiCorp
- Rocky Mountain Power
- Garkane Energy

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PREPARERS/CONTRIBUTORS

Name	Firm/Agency	Contribution/Responsibility
Douglas Koza	JBR Environmental Consultants, Inc. Conifer, Colorado	Senior Scientist - Project Manager, Wind, Solar, and Biomass Resources
Richard Butler	JBR Environmental Consultants, Inc. Sandy, Utah	Senior Scientist - Wind, Solar, and Biomass Resources
Josh Vittori	JBR Environmental Consultants, Inc Reno, Nevada	Forester – Biomass Resources
Kent Dastrup	BLM Cedar City Field Office	GIS Specialist – GIS Data and Mapping
Andrew Dubrasky	BLM Cedar City Field Office	GIS Coordinator – GIS Data and Mapping
Rob Wilson	BLM Cedar City Field Office	Lands and Realty Specialist – Wind and Solar Resources, Land Use Information
Douglas Page	BLM Cedar City Field Office	SW Utah Zone Forester – Biomass Resources