Final

Description of the Proposed Action and Alternatives

for the Programmatic Environmental Assessment Addressing Renewable Energy Projects

Kirtland Air Force Base, New Mexico

October
2017

Acronyms and Abbreviations

ABW	Air Base Wing
AFB	Air Force Base
AFGSC	Air Force Global Strike Command
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
DoD	Department of Defense
DOE	Department of Energy
EA	Environmental Assessment
EIS	Environmental Impact Statement
EO	Executive Order
EPAct 2005	Energy Policy Act of 2005
FONSI	Finding of No Significant Impact
FY	fiscal year
IDP	Installation Development Plan
MSW	municipal solid waste
MW	megawatt(s)
NEPA	National Environmental Policy Act
PEA	Programmatic Environmental Assessment
SPV	solar photovoltaic
USAF	U.S. Air Force
USC	United States Code
USFS	U.S. Forest Service

Cover Sheet

Final Description of the Proposed Action and Alternatives for the Programmatic Environmental Assessment Addressing Renewable Energy Projects, Kirtland Air Force Base, New Mexico

Responsible Agencies: U.S. Air Force, Air Force Global Strike Command, Kirtland Air Force Base (AFB)

Affected Location: Kirtland AFB, New Mexico

Report Designation: Description of the Proposed Action and Alternatives for a Programmatic Environmental Assessment

Abstract: This Description of the Proposed Action and Alternatives describes the U.S. Air Force proposal to develop and implement renewable energy technologies at Kirtland AFB. The Proposed Action is the programmatic execution of various electricity-generating renewable energy technologies at the installation. It includes renewable energy technology categories that meet general selection standards for suitability. The purpose of the Proposed Action is to implement installation energy goals to increase installation energy security, provide strategic flexibility in energy generating sources, allow for predictable and potentially reduced operational costs, and maximize resource availability through development of renewable energy-generating assets at Kirtland AFB. The Proposed Action is needed to meet renewable energy standards put forth by federal directives, including Executive Order 13693, *Planning for Federal Sustainability in the Next Decade*; Title II—Renewable Energy (42 United States Code [USC] § 15851 (2012)) of the Energy Policy Act (109 P.L. 58, 119 Stat. 594); Energy Independence and Security Act of 2007 (42 USC § 17001 et seq. (2012); 110 P.L. 140); "Goal Regarding Use of Renewable Energy To Meet Facility Energy Needs" (10 USC § 2911(e)(2012)); and the Kirtland AFB Installation Development Plan.

Under the No Action Alternative, Kirtland AFB would not develop and implement electricity-generating renewable energy technologies on the installation and therefore would not reduce the amount of electricity it receives from off-installation suppliers. It would continue to satisfy its electrical power requirements through purchase of all of its electricity off-installation from the Western Area Power Authority.

This Description of the Proposed Action and Alternatives will become Sections 1 and 2 of the Programmatic Environmental Assessment, which will analyze the potential for significant environmental and socioeconomic impacts associated with the Proposed Action and alternatives, including the No Action Alternative, and aid in determining whether a Finding of No Significant Impact can be prepared or an Environmental Impact Statement is required.

Written comments and inquiries regarding this document should be directed by mail to the Kirtland AFB National Environmental Policy Act Program Manager, 377 MSG/CEIEC, 2050 Wyoming Boulevard SE, Suite 116, Kirtland AFB, New Mexico 87117-5270, or by email to *KirtlandNEPA@us.af.mil*.

Final

DESCRIPTION OF THE PROPOSED ACTION AND ALTERNATIVES

FOR THE

PROGRAMMATIC ENVIRONMENTAL ASSESSMENT ADDRESSING RENEWABLE ENERGY PROJECTS AT KIRTLAND AIR FORCE BASE, NEW MEXICO

U.S. AIR FORCE

Kirtland Air Force Base, New Mexico

OCTOBER 2017

Table of Contents

Figures

Tables

Appendix

1. Purpose of and Need for the Proposed Action

1.1 Introduction

The U.S. Air Force (USAF) proposes to develop and implement electricity-generating renewable energy projects at Kirtland Air Force Base (AFB). This Description of the Proposed Action and Alternatives will become Sections 1 and 2 of the Programmatic Environmental Assessment (PEA), which will evaluate the potential environmental impacts resulting from the Proposed Action and No Action Alternative.

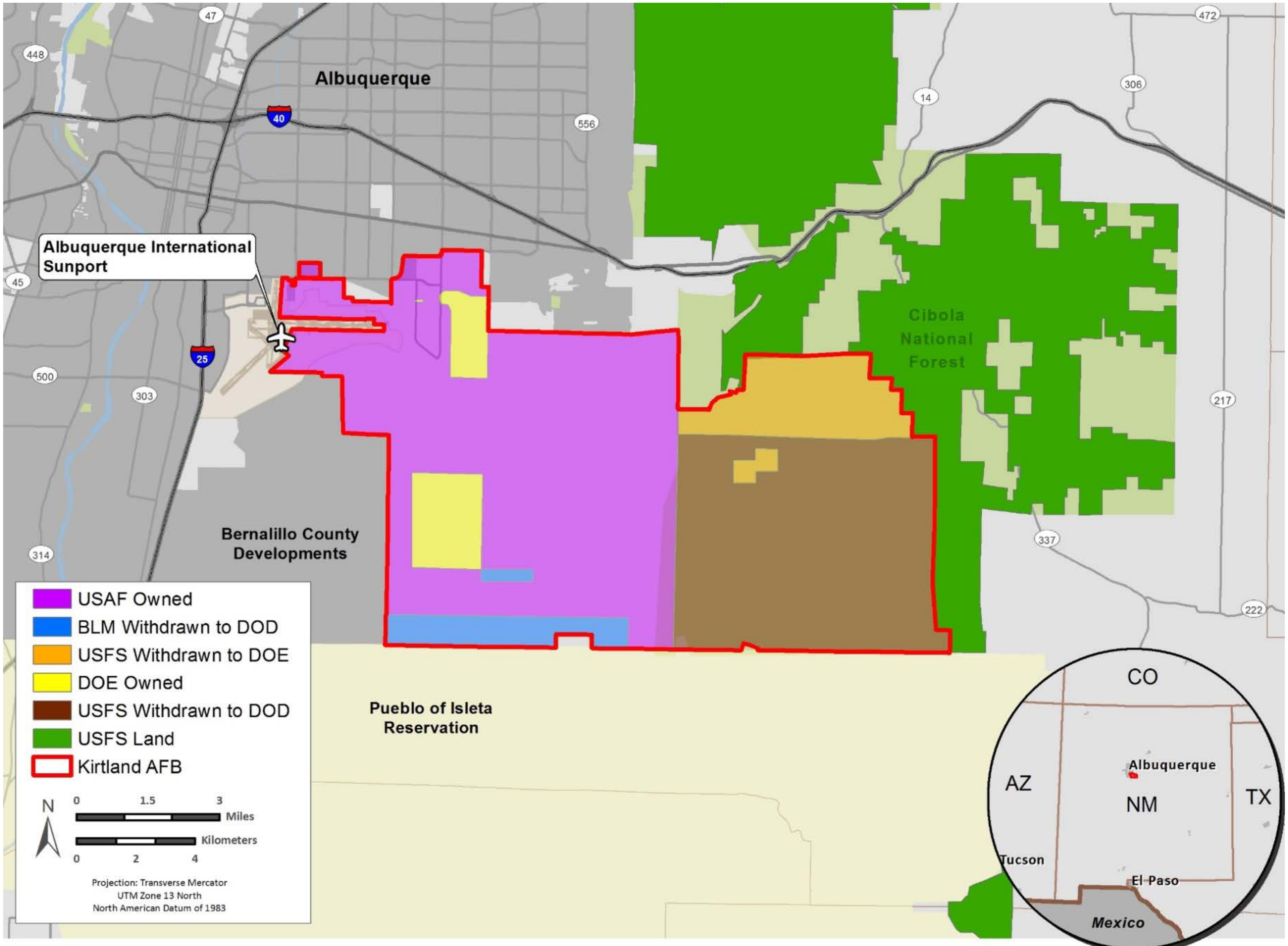
Declining costs, coupled with policy support, have led to increased deployment of renewable energy technology, with renewable sources accounting for 14.9 percent (6.5 percent hydropower, 5.6 percent wind, 1.5 percent biomass, 0.9 percent solar, and 0.4 percent geothermal) of net generation in the United States in 2016 (USEIA 2017a). Of the 2016 total nationwide utility-scale capacity additions, more than 60 percent were wind (8.7 gigawatts) and solar (7.7 gigawatts), with 33 percent (9 gigawatts) from natural gas. The 7.7 gigawatts of utility-scale solar electricity generating capacity added in 2016 was greater than all utility-scale solar that had been added through 2013. A total of 3.4 gigawatts of distributed solar photovoltaic (SPV) capacity (i.e., rooftop systems that are not part of the utility-scale numbers) was also added in 2016. With the exception of 2014, annual utility-scale solar additions have increased in each year since 2008 (USEIA 2017b). The trend in increased usage of renewable energy, including utility-scale solar technology, supports its availability for use by USAF.

The PEA will be prepared in accordance with the National Environmental Policy Act (NEPA) of 1969 (42 United States Code [USC] § 4321 et seq.) and the Council on Environmental Quality (CEQ) Regulations for Implementing NEPA (40 Code of Federal Regulations [CFR] §§ 1500–1508). The USAF is also required to adhere to the USAF NEPA-implementing regulations, 32 CFR § 989, as amended.

1.2 Project Location

Kirtland AFB is in Bernalillo County to the southeast of Albuquerque, New Mexico (see **Figure 1-1**). The land within the installation is owned by a variety of entities (see **Table 1-1**). The installation encompasses 51,585 acres with elevations that range from 5,200 to almost 8,000 feet above mean sea level. The Manzanita Mountains on its eastern boundary rise to over 10,000 feet (KAFB 2012a). The northwest corner of Kirtland AFB is developed. The remaining portion of the installation is relatively undeveloped and is used for training and testing missions.

Surrounding land adjacent to Kirtland AFB includes the U.S. Forest Service (USFS) Cibola National Forest to the northeast and east, the Isleta Pueblo Reservation to the south, Bernalillo County developments to the southwest, residential and business areas of the city of Albuquerque to the west and north, and the Albuquerque International Sunport directly to the northwest.



Source: ESRI Streetmap 2010

Figure 1-1. Kirtland AFB Vicinity Map with Land Ownership and Withdrawn Areas

Table 1-1. Kirtland AFB Land Ownership

Kirtland AFB Lands	Acres
USAF Fee Owned	25,612
USFS withdrawn to the Department of Defense (DoD)	15,891
Bureau of Land Management (BLM) withdrawn to DoD	2,549
USAF Total	44,052
Department of Energy (DOE) Fee Owned	2,938
USFS withdrawn to DOE	4,595
DOE Total	7,533
GRAND TOTAL	**51,585**

Source: KAFB 2012b

Kirtland AFB was established in the late 1930s as a training installation for the U.S. Army Air Corps. In January 1941, construction of the Albuquerque Army Air Base began with permanent barracks, warehouses, and a chapel. On 1 April 1941, a single B-18 bomber arrived marking the official opening of Albuquerque Army Air Base. Troops soon followed and the installation grew rapidly with the involvement of the United States in World War II. The installation served as a training site for aircrews for many of the country's bomber aircraft, including the B-17, B-18, B-24, and B-29.

In February 1942, Albuquerque Army Air Base was renamed Kirtland Army Air Field in honor of Colonel Roy C. Kirtland, one of the Army's earliest aviation pioneers. In 1942, the U.S. Army Air Corps established a training depot for aircraft support and logistics to the east of Kirtland Army Air Field, near the original private airport, Oxnard Field. The depot became known as Sandia Base. With the completion of the ground crew training program in 1943, Sandia Base was used as a convalescent center for wounded aircrew members, and then as a storage and dismantling facility for war-weary and surplus aircraft as the war ended.

The war years at Kirtland Army Air Field continued to be filled with distinguished records of training entire flight crews for the B-17 and B-24 bombers, and the installation's three schools of advanced flying, bombardier training, and the multi-engine school operated at full capacity. In February 1945, Kirtland Army Air Field participated in training combat crews for the B-29 Super Fortress, which eventually brought an end to the hostilities with Japan by dropping the first atomic bombs on Hiroshima and Nagasaki.

In July 1945, the Los Alamos Laboratory Z-Division was formed to manage the engineering design, production, assembly, and field testing of non-nuclear components of nuclear bombs. In September 1945, the Z-Division transferred its field-testing group to Sandia Base along with staff from the U.S. Army Air Corps' 509th Composite Group at Wendover Air Base in Utah to do weapon assembly. In 1948, under the U.S. Atomic Energy Commission, the Z-Division was renamed Sandia Laboratory and became a separate branch from the Los Alamos Laboratory. The U.S. Congress designated Sandia Laboratories as a National Laboratory in 1979.

In February 1946, Kirtland Army Air Field was placed under the Air Materiel Command and its flying and training activities terminated. Its new mission entailed flight test activities for Sandia

Laboratory, development of aircraft modifications for weapons delivery, and characterizing nuclear weapon ballistics. In 1947, the U.S. Army Air Corps became the USAF, and Kirtland Army Air Field was renamed Kirtland AFB. In 1949, the USAF established its own Special Weapons Center and testing laboratory at Kirtland Field near Sandia, which eventually became Phillips Laboratory and subsequently the Air Force Weapons Laboratory. A majority of the test and evaluation activities were conducted on a 46,000-acre tract in the Manzano Mountains, referred to as the New Mexico Proving Ground, on the southern part of Kirtland AFB, which included USFS lands withdrawn for DoD and U.S. Atomic Energy Commission research, testing, and development activities. The establishment of these activities at Kirtland AFB was considered ideal due to its proximity to the Los Alamos Laboratory and Sandia Base.

The late 1940s and 1950s were expansion years as both Kirtland AFB and Sandia Base played increasing roles in the nation's defense efforts. New buildings, hangars, and the east-west runway, which is now owned by the city of Albuquerque, were constructed. During this period, air defense, weather, and atomic test squadrons operated from Kirtland AFB, and personnel from both installations took part in 12 nuclear test series conducted by the U.S. Atomic Energy Commission in Nevada and the Pacific. In 1958, efforts were underway between the United States and the Soviet Union to agree on a moratorium for atmospheric nuclear testing. The anticipated limitations on determining weapons effects inspired efforts by the Special Weapons Center and Sandia Laboratory to develop methods of simulating nuclear effects with non-nuclear techniques. The Limited Nuclear Test Ban Treaty was signed with the Soviet Union in late 1962, prohibiting nuclear testing in the atmosphere and space, as well as under water.

In 1971, Kirtland AFB and its adjoining military neighbors to the east, Sandia and Manzano Army Bases, were merged to form what is known as Kirtland AFB. On 1 January 1993, Kirtland AFB changed hands to the newly formed Air Force Materiel Command where it remained until 1 October 2015, when it was transferred to the Air Force Global Strike Command (AFGSC).

Kirtland AFB is the sixth largest installation in the USAF. It is operated by the 377th Air Base Wing (377 ABW), which is a unit of AFGSC's 20th Air Force and the host unit at Kirtland AFB. Missions at Kirtland AFB fall into four major categories: research, development, and testing; readiness and training; munitions maintenance; and support to installation operations for more than 100 mission partners. The primary mission of 377 ABW is to execute nuclear, readiness, and support operations for American airpower. Kirtland AFB is a center for research, development, and testing of nonconventional weapons, space and missile technology, laser warfare, and much more. Organizations involved in these activities include the Air Force Nuclear Weapons Center, Air Force Operational Test and Evaluation Center, Space and Missile Systems Center, Air Force Inspection Agency, Air Force Safety Center, Air Force Research Lab, Department of Energy, and Sandia National Laboratories. In addition, 377 ABW ensures readiness and training of airmen for worldwide duty and operates the airfield for present and future USAF operations, prepares personnel to deploy worldwide on a moment's notice, and keeps the installation secure. Mission partners involved in these activities include the 58th Special Operations Wing, 150th Special Operations Wing (New Mexico Air National Guard), and the USAF Pararescue School.

1.3 Renewable Energy Program

U.S. Air Force

The USAF energy goals and strategy are aligned with renewable energy policies developed throughout the federal government and contained in the following documents:

- Title II—Renewable Energy (42 USC § 15851 (2012)) of the Energy Policy Act (109 P.L. 58, 119 Stat. 594): The Energy Policy Act of 2005 (EPAct 2005) was developed in response to rising concerns about the security of domestic energy supplies. Title II of EPAct 2005 set requirements for renewable power use at federal facilities and defined the sources from which renewable energy is obtained. It requires the federal government to consume no less than 7.5 percent of its electricity from renewable sources in and after fiscal year (FY) 2013.
- Energy Independence and Security Act of 2007 (42 USC § 17001 et seq. (2012); 110 P.L. 140): Section 431 requires federal buildings to reduce total energy use 30 percent by 2015 (FY 2003 baseline). Section 526 prohibits federal agencies from purchasing fuels with higher lifecycle greenhouse gas emissions than conventional petroleum fuels.
- 10 USC § 2911(e)(2012): This statute requires DoD to submit an energy performance master plan and performance goals, including the goal to produce or procure 25 percent of the total quantity of energy consumed within its facilities from renewable sources by 2025 and each fiscal year thereafter.
- Executive Order (EO) 13693, *Planning for Federal Sustainability in the Next Decade*: EO 13693 replaced EO 13514, *Federal Leadership in Environmental, Energy, and Economic Performance*, and the 2013 Presidential Memorandum "*Federal Leadership on Energy Management*" and set new goals and timelines for use of renewable electrical energy by federal agencies. Under EO 13693, federal agencies must maintain leadership in sustainability and greenhouse gas emission reductions. Specifically, federal agencies shall ensure that by FY 2025 at least 25 percent of the total amount of building electric energy and thermal energy they use shall be clean energy, accounted for by renewable electric energy and alternative energy. EO 13693 set the following goals and timelines for use of renewable electrical energy by federal agencies:
    - The percentage of building electrical energy and thermal energy that shall be clean energy, accounted for by renewable electrical energy and alternative energy:
        - Not less than 10 percent in FYs 2016 and 2017
        - Not less than 13 percent in FYs 2018 and 2019
        - Not less than 16 percent in FYs 2020 and 2021
        - Not less than 20 percent in FYs 2022 and 2023
        - Not less than 25 percent by FY 2025 and each year thereafter.
    - The percentage of building electrical energy consumed by the agency that is renewable electrical energy shall be:
        - Not less than 10 percent in FYs 2016 and 2017

        - Not less than 15 percent in FYs 2018 and 2019
        - Not less than 20 percent in FYs 2020 and 2021
        - Not less than 25 percent in FYs 2022 and 2023
        - Not less than 30 percent by FY 2025 and each year thereafter.
    - Actions that may be considered in order to meet the percentage goals for building electrical energy and thermal energy include the following:
        - Install agency-funded renewable energy at federal facilities to include installing fuel cell energy systems
        - Contract for the purchase of energy that includes installation of renewable energy at a federal facility.
- USAF published its "Air Force Energy Plan" in May 2010 with the vision to "make energy a consideration in all we do" (USAF 2010). Goals of the plan include the following:
    - Reduce energy demand by installations, flight operations, and ground operations.
    - Increase energy supply by developing and utilizing renewable and alternative energy wherever possible.
    - Change the culture to increase energy awareness in daily operations.
    - Meet energy "End State Goals" by 2030:
        - Installations meet USAF energy security criteria, while optimizing the mix of on- and off-installation generation.
        - Aircraft fly on alternative fuel blends if cost competitive, domestically produced, and have a lifecycle greenhouse gas footprint equal to or less than petroleum.
        - Forward Operating Bases are capable of operating on renewable energy.
        - Optimize energy utilization as a tactical advantage across disciplines.

Kirtland AFB

The Kirtland AFB installation commander issued a memorandum that outlines the installation's commitment to conducting its mission in an environmentally responsible manner (KAFB 2015). Specifically, it commits to the responsible use of energy throughout the installation with practices and procedures to conserve energy, improve energy efficiency, and promote sustainability.

The Kirtland AFB Installation Development Plan (IDP) contains a Strategic Vision Alignment Summary Matrix that depicts how the IDP aligns, supports, and contributes to realizing the goals and objectives of DoD, USAF, Air Force Civil Engineer Center, AFGSC, and 377 ABW (KAFB 2016). The matrix creates the foundation upon which a prioritization strategy for future projects can be built at the installation. One of the goals of the Strategic Vision Alignment is the pursuit of energy surety. To achieve that goal, the IDP lists several objectives, including developing renewable energy, exploring net zero energy opportunities, and improving and expanding energy network metering.

EO 13693 established energy use intensity reduction goals and renewable energy development goals for 2016 through 2025. These goals are interconnected in that renewable energy generated on Kirtland AFB not only counts toward the renewable energy development goals, but it also reduces energy use intensity because it is not reported as energy consumed.

EO 13693 and the Kirtland AFB IDP address renewable energy standards and goals beyond the use of renewable electric energy. These goals include technologies that focus on reducing energy consumption through energy conservation and building performance such as solar hot water and solar ventilation preheat. While future renewable energy oriented actions may be taken by Kirtland AFB, including use of the previously mentioned technologies, the actions addressed under the PEA are limited to those that use renewable energy sources as a means to generate electricity.

1.4 Purpose and Need

The purpose of the Proposed Action is to implement installation energy goals to increase installation energy security, provide strategic flexibility in energy generating sources, allow for predictable and potentially reduced operational costs, and maximize resource availability through the development of renewable energy-generating assets at Kirtland AFB.

The Proposed Action is needed to meet renewable energy standards put forth by federal directives, including EO 13693; Title II—Renewable Energy (42 USC § 15851 (2012)) of the EPAct 2005 (109 P.L. 58, 119 Stat. 594); Energy Independence and Security Act of 2007 (42 USC § 17001 et seq. (2012); 110 P.L. 140); "Goal Regarding Use of Renewable Energy To Meet Facility Energy Needs" (10 USC § 2911(e)(2012)); and the Kirtland AFB IDP.

1.5 Scope of the Programmatic Environmental Assessment

The scope of the PEA includes the actions proposed, alternatives considered, a description of the existing environment, and direct, indirect, and cumulative impacts. The PEA will include analysis of the potential impacts of programmatic implementation of various renewable energy technologies at the installation, such as SPV and geothermal energy. Use of SPV technology could include the installation of an SPV array with battery storage capacity and small rooftop/carport SPV systems in the cantonment area of the installation. Analysis of renewable energy technologies under the PEA will provide a format for comprehensive cumulative impacts analysis by examining renewable energy activities as a whole. The PEA also will identify appropriate mitigation measures that are not included in the Proposed Action in order to avoid, minimize, reduce, or compensate for adverse environmental impacts.

The PEA will reduce duplication of effort by analyzing general aspects of use of renewable energy technologies and establishing a framework for environmental impact analysis of future site-specific actions. The impacts of future site-specific actions can be addressed in subsequent NEPA evaluations, per CEQ regulations (40 CFR § 1502.20). The use of tiering allows future documents to be specific in their analysis of individual renewable energy projects when they are more fully developed and designed while referencing previous environmental analyses.

1.5.1 NEPA Compliance Requirements

NEPA is a federal law requiring the analysis of potential environmental impacts associated with proposed federal actions before the actions are taken. The intent of NEPA is to make decisions informed by potential environmental consequences and take actions to protect, restore, or enhance the environment. NEPA established the CEQ, which is responsible for ensuring federal agency compliance with NEPA. CEQ regulations mandate all federal agencies use a prescribed approach to environmental impact analysis. The approach includes an evaluation of the potential environmental consequences associated with a proposed action and considers alternative courses of action.

The process for implementing NEPA is outlined in 40 CFR §§ 1500–1508, *Regulations for Implementing the Procedural Provisions of the National Environmental Policy Act*. These CEQ regulations specify that an Environmental Assessment (EA) be prepared to determine whether a Finding of No Significant Impact (FONSI) is appropriate or preparation of an Environmental Impact Statement (EIS) is necessary. An EA considers the effects (direct, indirect, and cumulative) of a proposed action on the human environment. It uses a systematic, interdisciplinary approach to evaluate a proposed action and possible alternatives and must disclose all considerations to the public. An EA can aid in an agency's compliance with NEPA when an EIS is unnecessary and facilitate preparation of an EIS when one is required.

USAF regulations under 32 CFR § 989 provide procedures for environmental impact analysis for USAF to comply with NEPA and CEQ regulations. Air Force Policy Directive 32-70, *Environmental Quality*, states USAF will comply with applicable federal, state, and local environmental laws and regulations, including NEPA. If significant impacts are predicted under NEPA, USAF would decide whether to conduct mitigation to reduce impacts below the level of significance, prepare an EIS, or abandon the Proposed Action. The PEA would also be used to guide USAF in implementing the Proposed Action in a manner consistent with USAF standards for environmental stewardship should the Proposed Action be approved for implementation.

1.5.2 Affected Resources

The following resource areas will be analyzed and discussed in detail for potential impacts from implementation of the Proposed Action and alternatives: Airspace Management, Noise, Visual Resources, Air Quality, Geological Resources, Water Resources, Biological Resources, Cultural Resources, Infrastructure and Transportation, Hazardous Materials and Wastes, Safety, and Socioeconomics and Environmental Justice.

1.5.3 Intergovernmental and Stakeholder Coordination

NEPA requirements help ensure environmental information is made available to the public during the decision-making process and prior to an action's implementation. A premise of NEPA is that the quality of federal decisions will be enhanced if the public is involved in the planning process. In compliance with NEPA, Kirtland AFB will notify relevant stakeholders about the Proposed Action and alternatives (see **Appendix A** for stakeholder coordination materials). The notification process will provide these stakeholders the opportunity to cooperate with Kirtland AFB and provide comments on the Proposed Action and alternatives. Comments received from the various stakeholders will be considered during preparation of the PEA and included in **Appendix A**.

EO 13175, *Consultation and Coordination with Indian Tribal Governments*, directs federal agencies to coordinate and consult with Native American tribal governments whose interests might be directly and substantially affected by activities on federally administered lands. Consistent with EO 13175; Department of Defense Instruction 4710.02, *DoD Interactions with Federally-Recognized Tribes*; and Air Force Instruction 90-2002, *Air Force Interaction with Federally-Recognized Tribes*, federally recognized tribes that are historically affiliated with the Kirtland AFB geographic region will be invited to consult on all proposed undertakings that potentially affect properties of cultural, historical, or religious significance to the tribes. The tribal consultation process is distinct from NEPA consultation or the intergovernmental coordination process, and it requires separate notification of all relevant tribes. The timelines for tribal consultation are also distinct from those of other consultations. The Kirtland AFB point-of-contact for Native American tribes is the Installation Commander. The Native American tribal governments to be coordinated or consulted with regarding the Proposed Action are listed in **Appendix A** along with all USAF correspondence. Comments received from the various Native American tribes will be considered during preparation of the PEA and included in **Appendix A**.

1.5.4 Public and Agency Review of Draft PEA

A Notice of Availability for the Draft PEA will be published in the *Albuquerque Journal* announcing the availability of the Draft PEA. The publication of the Notice of Availability will initiate a 30-day public review period. A copy of the Draft PEA will be made available for review at the San Pedro Public Library at 5600 Trumbull SE, Albuquerque, NM 87108. A copy of the Draft PEA will also be made available for review online at *http://www.kirtland.af.mil* under the environmental information tab. At the closing of the public review period, applicable comments from the general public and intergovernmental coordination/consultation will be incorporated into the analysis of potential environmental impacts performed as part of the PEA, where applicable, and included in **Appendix A** of the Final PEA.

This page intentionally left blank.

2. Proposed Action and Alternatives

This section describes the Proposed Action (**Section 2.1**), No Action Alternative (**Section 2.2**), selection standards for evaluating renewable energy technologies (**Section 2.3**), and a discussion of renewable energy technologies considered (**Section 2.4**). **Section 2.5** provides a summary of the renewable energy technologies considered and discusses which technologies will be carried forward for further analysis. The final section, **Section 2.6**, identifies the Preferred Alternative.

2.1 Proposed Action

This Description of the Proposed Action and Alternatives describes the USAF proposal to develop and implement renewable energy technology at Kirtland AFB. The Proposed Action is the programmatic execution of various electricity-generating renewable energy technologies at the installation. It includes renewable energy technology categories that meet general suitability criteria (Level 1 selection standards).

The Proposed Action does not include specific projects. Future proposed specific projects for renewable energy technologies that meet the Level 1 selection standards would be evaluated against site selection criteria (Level 2 selection standards) and undergo separate NEPA analysis.

Sections 2.1.1 through **2.1.4** provide a general discussion regarding construction, connection, storage and distribution, and operation and maintenance of renewable energy projects. **Sections 2.3** through **2.5** present the categories of renewable energy technology that are commercially available and potentially suitable for implementation at Kirtland AFB.

2.1.1 Construction

The electrical utility lines, substations, and transformer equipment installed as part of the Proposed Action would be installed among existing compatible equipment and existing utility rights-of-way as much as feasible and would be seamlessly integrated into the electrical distribution system. During construction, surface vegetation and trees within the project site would be cleared and the land graded in accordance with the specifics of the project design. Temporary construction laydown areas for materials, equipment, and parking also may be required within the project site. Construction would include actions such as installing foundations and footers, assembly of the renewable energy system, and extending utility lines (aboveground or underground based on project site conditions). After construction, the project site would be seeded with herbaceous groundcover. Temporary construction laydown areas would be restored to pre-construction conditions.

2.1.2 System Interconnection

To safely transmit electricity to the installation load demand and comply with the local utility's grid-connection requirements, the following areas must be addressed:

- *Power conditioning equipment.* A renewable energy project could be variable in its power generation output, which can contribute to the instability of the electric grid.

Power conditioning equipment would be required to ensure that the power generated by a renewable energy source matches the voltage and frequency of the electricity flowing through the grid. An inverter could serve this purpose by converting the variable direct current output of a renewable energy system into a utility frequency alternating current that could be fed into a commercial electrical grid or used by a local, off-grid electrical network.

- *Substation.* A project substation may be needed to provide the connection with the local electrical grid. The project substation would have a low side and a high side, as defined by the point of power transformation from the low side stepped up in voltage to match the grid specifications in the transmission system (high side). Each renewable energy project would include the necessary electrical transmission line to connect the proposed substation, if required, to the electrical grid.
- *Safety equipment.* Safety equipment to ensure safe operation must include the means to limit access to authorized individuals as well as proper signage. Personal protective equipment needed when working with renewable energy systems varies. For example, a SPV system may require fall protection, fire-rated clothing, arc flash protection, hot gloves, protective eyewear, and safety footwear.
- *Metering and instrumentation.* If a grid-connected small renewable energy system produces excess power it cannot use or store, the Public Utility Regulatory Policy Act of 1978 requires power providers to purchase excess power at a rate equal to what it costs the power provider to produce the power itself. This requirement can be implemented, as needed, through various metering arrangements.

2.1.3 Storage and Distribution

Should Kirtland AFB choose to become energy independent, it might also consider energy storage options, which could include use of batteries, hydrogen storage, or fuel cells. For example, an energy storage system would allow the installation to produce solar power during the day, store it, and then use the power at night when the solar systems are no longer generating power. In addition to allowing Kirtland AFB to become energy independent, an energy storage system would provide Kirtland AFB the ability to use all of the energy produced by the various proposed generation sources, and provide energy security for a subset of critical facilities, including as part of a microgrid. A microgrid is a localized grouping of energy generation, storage, and loads that would normally operate through connection to the central utility grid. Because generation, storage, and end uses are all connected to a microgrid, it would be able to function autonomously if it ever became disconnected from the central utility grid and would, therefore, provide Kirtland AFB with energy security.

2.1.4 Operation and Maintenance

An effective Operations and Maintenance program enhances the likelihood a system will perform at or above its projected production rate and cost over time. Renewable energy system operations would include the following five areas: Administration of Operations (ensures effective implementation and control of Operations and Maintenance services including curation of as-built drawings, equipment inventories, owners and operating manuals, and warranties);

Conducting Operations (ensures efficient, safe, and reliable process operations including making decisions about maintenance actions based on cost/benefit analysis); Directions for the Performance of Work (specifies the rules and provisions to ensure that maintenance is performed safely and efficiently); Monitoring (maintains monitoring system and analysis of resulting data to remain informed on system status); and Operator Knowledge, Protocols, Documentation (ensures that operator knowledge, training, and performance will support safe and reliable plant operation).

A typical renewable energy system maintenance program would include four types of maintenance procedures: Administration of Maintenance (ensures effective implementation, control, and documentation of maintenance activities and results); Preventative Maintenance (set by the operations function and is influenced by a number of factors such as equipment type and environmental conditions); Corrective Maintenance (required to repair damaged or replace failed components); and Condition-based Maintenance (use of real-time information from data loggers to schedule preventative measures such as cleaning) (NREL 2016).

At least once a year, Operations and Maintenance personnel would conduct a general inspection of the renewable energy equipment. Routine maintenance would be required for all renewable energy systems. For example, SPV arrays would require panel washing and panel replacement.

Safety requirements during system servicing would include the use of lockout/tagout procedures and personal protective equipment, adherence to procedures for safely disconnecting live circuits, and observation of and compliance with all system signage and warnings.

2.2 No Action Alternative

Under the No Action Alternative, Kirtland AFB would not develop and implement electricity-generating renewable energy technologies on the installation and it would not reduce the amount of electricity it receives from off-installation suppliers. It would continue to satisfy its electrical power requirements through purchase of all of its electricity off-installation from the Western Area Power Authority.

The No Action Alternative would not meet the purpose of and need for the Proposed Action as described in **Section 1.4**; however, USAF Environmental Impact Analysis Process (32 CFR § 989.8[d]) requires consideration of the No Action Alternative. In addition, CEQ guidance recommends inclusion of the No Action Alternative in an EA to assess any environmental consequences that may occur if the Proposed Action is not implemented. Therefore, this alternative will be carried forward for detailed analysis in the PEA. The No Action Alternative also serves as a baseline against which the Proposed Action can be compared.

2.3 Renewable Energy Technology Selection Standards

To warrant detailed evaluation in the PEA, an alternative must be reasonable. Reasonable alternatives include those that are practical or feasible from a technical and economic standpoint and use common sense, rather than simply being desirable from the standpoint of the applicant. To be considered reasonable, an alternative must meet the purpose of and need for the action, be feasible and able to be implemented, and be suitable for consideration by decision makers.

Guidance for complying with NEPA requires an assessment of potentially effective and reasonable alternatives for implementing the Proposed Action. An organized approach to evaluating alternatives can identify reasonable ways to achieve the Proposed Action's purpose and avoid unnecessary impacts. In accordance with 32 CFR § 989.8(c), the development of selection standards is an effective tool for identifying, comparing, and evaluating reasonable and feasible alternatives in NEPA documents. Two levels of selection standards have been developed to evaluate potential renewable energy technologies and specific projects within the acceptable technology categories.

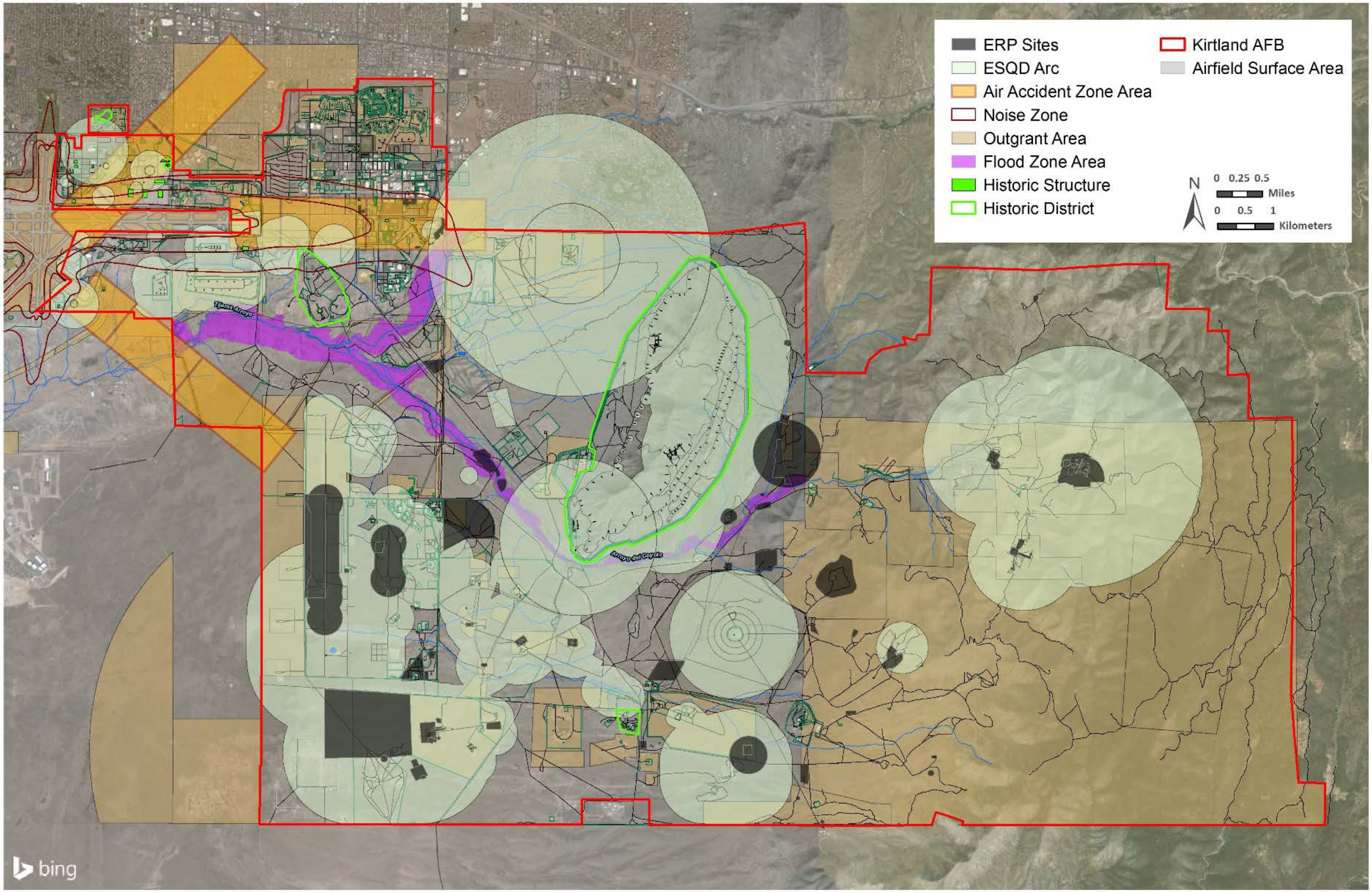
The first level of the evaluation process, which is applicable for the PEA, assesses the categories of renewable energy technology that are commercially available and potentially suitable for implementation at Kirtland AFB. This level of evaluation considers how a particular category of renewable energy generation would meet important general selection standards such as compatibility with the installation's mission, land use objectives, future development, and community relationship. Application of the first level selection standards will identify viable renewable energy technologies for use at the installation.

The second level of the evaluation process, which would occur in the future as individual projects are moved forward for development, assesses the suitability of locating a renewable energy project at a particular site on the installation. The second level selection standards focus on site-specific characteristics such as proximity to the installation electrical system, size and topography, compatibility with adjacent land uses, resource issues (e.g., wetlands, endangered species), and tribal considerations. Areas within Kirtland AFB constrained by operational and environmental limitations are shown in **Figure 2-1**.

Level 1 Selection Standards

The first level of evaluation, which was developed to be consistent with the purpose of and need for the Proposed Action and address pertinent mission, land use, and technology factors, assesses the suitability of renewable energy technologies for implementation at Kirtland AFB. These selection standards are used in the evaluation of renewable energy technologies in **Section 2.4**. To be considered reasonable and suitable for implementation at Kirtland AFB, a renewable energy technology must meet the following first level selection standards:

- *Mission compatibility.* The technology would need to be compatible with the mission and training at the installation. For instance, a renewable energy technology must not adversely impact military training.
- *Compatible land use.* The technology must be compatible with the land use objectives of the Kirtland AFB IDP. Compatible land uses would consider all large-scale constraints applicable to withdrawn lands or outgrants and would avoid areas with environmental or operational constraints.



ERP – Environmental Restoration Program
ESQD – Explosive Safety Quantity Distance

Figure 2-1. Land Use Constraints at Kirtland AFB

- *Feasibility.* The factors supporting use of a particular renewable energy technology must be sufficient to ensure the implementation of that technology category is feasible and sustainable. Factors include cost (initial capital and operational) and energy source characteristics.
- *Mature technology.* The renewable energy technology must be supported by mature and proven technology.
- *Community relationship.* Use of a particular renewable energy technology must enhance or not harm Kirtland AFB's relationship with the surrounding community.

Level 2 Selection Standards

The second level of selection standards would be used in the future to evaluate potential sites for specific renewable energy projects within the renewable energy technology categories that have been determined to be reasonable against the first level selection standards. These second level selection standards would evaluate whether a project is suitable for a particular location and compatible with applicable constraints and adjacent land uses. The second level selection standards are as follows:

- Sites must be undeveloped and capable of accommodating the appropriate footprint of the proposed facility, and, if possible, should also have additional space available to accommodate future modification or expansion.
- If a renewable energy technology would be applied to an existing structure or facility, it must be incorporated into that facility such that it does not negatively affect the mission or operation of that structure or facility.
- Sites must meet anti-terrorism/force protection setbacks and other safety criteria (e.g., height restrictions around airfield). Airfield Clear Zones and existing utility rights-of-way must also be avoided.
- Site topography must be suitable to the particular type of project; for instance, land areas for development of ground-mounted SPV systems would need to be relatively flat (i.e., less than 5 percent slope).
- Sites must not be encumbered by wetlands, protected plant or animal species habitat, or known cultural resources.
- Sites must not adversely impact the status of existing Installation Restoration Program sites.
- Sites must meet the requirements of the Air Force Handbook 32-1084, Facility Requirements (1 Sep 96), the Kirtland AFB Architectural Compatibility Plan, and other applicable guidance. These requirements ensure that informed decisions regarding standards for site, landscape, and buildings are made when considering project design, construction, and maintenance.
- Sites must support suitable access for connection to the installation electrical system. The installation electrical system must be capable of receiving, or upgradable to receive, the energy produced.

- Sites must have reasonable access to existing roadways to facilitate construction and support maintenance.
- Sites must require minimal grading/site preparation.
- Projects must consider, to the extent economically feasible and technically practical, use of land areas that, due to their former use, are not readily convertible to otherwise productive use (e.g., formerly contaminated sites and landfills), consistent with EO 13693, *Planning for Federal Sustainability in the Next Decade*. Such sites must reflect that remedial actions have been properly terminated, operations have achieved proper closure, and the site conditions are protective of human health and the environment.

2.4 Evaluation of Renewable Energy Technologies

Renewable energy comes from sources that are constantly replenished such as sunlight, wind, geothermal heat, and ocean waves, tides, and currents. However, selection of the most appropriate and cost-effective renewable energy technologies is dependent on the particular features and mission of a given location. The following renewable energy technologies have been considered for use at Kirtland AFB. The evaluation of each of these technologies considers their suitability relative to the first level selection standards presented in **Section 2.3**.

2.4.1 Solar Photovoltaic

SPV systems are based on the use of semiconductors, which are materials that can convert sunlight directly to electricity. To produce electricity at utility scale, many individual solar cells are connected as a module; modules are combined to make individual solar panels; and solar panels are grouped into arrays that produce direct current electricity.

The power-producing components of utility-scale SPV facilities are the solar field, or array, which contains the SPV panels, the power conditioning system that contains an inverter to convert the produced direct current to alternating current, and the transformer to boost voltage for feeding electricity into the power grid. The power conditioning system also contains devices that can sense grid destabilization and automatically disconnect the SPV facility from the grid, if needed.

The two types of SPV technologies are flat-plate and concentrating systems. The solar cell materials for both systems are typically a thin film in a weather-resistant enclosure. The two systems differ in the manner in which they capture sunlight and direct it to the solar cell materials. In flat-plate SPV systems, the modules are placed in the solar field, either in a fixed position optimal for capturing sunlight, or on a tracking system that follows the sun’s path to optimize power production. A concentrating SPV system converts light energy into electrical energy in the same way that the conventional flat-plate SPV system does, but uses an advanced optical system to focus a large area of sunlight onto each cell for maximum efficiency. It also usually incorporates tracking devices (CPV Consortium 2017).

Candidate sites at Kirtland AFB for an SPV array would be undeveloped and between 200 and 500 acres in size, which would allow for a generating capacity of 10 to 20 megawatts (MW). The array would be connected to existing substations and transmission lines on the installation via extension of a connection line along existing roads or existing utility rights-of-way. The connection line between the array and the point at which it connects to the local grid could be up to 1 mile. Because the existing electrical infrastructure is subject to change due to Kirtland AFB's ongoing upgrades, the connection line route would be determined during the design phase of the array. It is possible that an array could require the construction of a new substation that would need to be connected to the existing electrical system. The decision to place electrical connections above or below ground would be contingent on the location of the SPV system. In developed areas of the installation, especially near the flight line, buried electrical lines could be required. However, most locations would allow for electrical lines to be placed overhead, which is generally less intrusive and more cost effective.

SPV systems could also be installed on existing facilities, including building rooftops and parking areas, such that the function of those facilities would not change or be impaired. SPV systems installed in parking areas would typically use a carport structure so that the system would not impede or reduce available parking.

Analysis

SPV systems have been a major component of the renewable energy generating capacity added nationwide in recent years. SPV is a mature technology that can be implemented in a number of locations and at varying scales at Kirtland AFB, and is compatible with the land use and mission at the installation. Future development of SPV at Kirtland AFB would require a site-specific evaluation to ensure each project meets the second level screening standards.

2.4.2 Wind Energy

Wind energy is the transformation of wind into mechanical power through a turbine, which is then converted into electricity through a generator. Turbines range in size from small, residential units with capacities less than 100 kilowatts to large-scale 2- to 3-MW turbines used in commercial wind farms. The United States has an installed wind energy capacity of 82,183 MW, with over 52,000 wind turbines operating in 40 states plus Guam and Puerto Rico (American Wind Energy Association 2016).

Wind as a renewable resource generally requires large amounts of land. The average total area required of 172 wind farm projects analyzed nationwide is 86 acres per MW (NREL 2009). However, wind farms allow for multiple land uses. Wind facilities have variable power output that require different management strategies from other forms of power generation, and can result in higher costs for integration into the grid. Utility-scale wind farms use large wind turbines capable of high energy output. The widely used GE 1.5-MW wind turbine consists of 116-foot blades atop a 212-foot tower for a total height of 328 feet (National Wind Watch 2017). Some turbines reach total heights of over 400 feet.

Analysis

Large wind turbines could pose challenges to the installation mission due to the height of the towers and the effects they can produce on various types of radars, aircraft operations, and other critical systems. Given the large areas of land required for this technology and the amount of land at Kirtland AFB that is under constraint for a variety of reasons, insufficient area is available for development of a wind farm. Wind turbines can also generate low frequency vibrations that can be problematic for locations that are sensitive to seismic noise, such as seismic monitoring stations and other sensitive scientific instruments (Keele University 2005). The visual impact of wind turbines is also frequently a point of contention.

Wind energy is not compatible with the mission or overall land use plan at Kirtland AFB. Additionally, it is not compatible with the installation's constraints to land use including tribal, flight operations, and helicopter landing zones near the airport. Vibrations generated by wind turbines could also interfere with the operation of sensitive equipment at Kirtland AFB. Therefore, use of wind energy technology is not suitable for use at Kirtland AFB and is dismissed from further consideration.

2.4.3 Geothermal Energy

Geothermal energy is generated by natural heat stored in the Earth. The temperature difference between the Earth's core and its surface drives a continuous conductive process where molten rock (magma) inside the Earth heats rock and water to produce geothermal heat. The heat produced by a geothermal source is used to generate electric power via heat exchangers and turbines. Where available, geothermal sources produce full-time baseload power, unlike the intermittent energy provided by solar and wind. In 2015, the United States had 3.7 MW of installed geothermal electricity capacity, with over 1,250 MW of capacity in development (Geothermal Energy Association 2016).

Geothermal energy can be harnessed through direct use, electrical generation, or heat pumps. Direct-use applications include heating buildings, growing plants in greenhouses, drying crops, heating water at fish farms, and several industrial processes. There are three types of geothermal power plants: dry steam, flash steam, and binary cycle. Electrical generation occurs when steam from underground wells turns a turbine, which drives a generator to produce electricity. Geothermal heat pumps are able to heat, cool, and, if so equipped, supply buildings with hot water.

Analysis

Where natural heat sources exist, geothermal is an excellent source of energy for USAF installations; however, the exploration and production costs of geothermal wells are increased in the absence of proven resources. In April 2010, a team from the National Renewable Energy Laboratory conducted a reconnaissance assessment of the geothermal potential at Kirtland AFB. They concluded that there appears to be indications of potential geothermal activity within the installation; however, further investigation is likely necessary.

Geothermal as a source of renewable energy electricity is compatible with the mission and land use at Kirtland AFB. It is a mature technology that does not occupy a large footprint, so it is feasible to implement. The feasibility of generating electricity at Kirtland AFB through the use of geothermal resources is uncertain at this time because it is unknown whether or not an adequate geothermal source exists at the installation. However, depending on the results of further investigation of geothermal activity, this technology may remain a potential renewable energy source in the future.

2.4.4 Biomass (Waste-to-Energy)

Biomass electricity is generated from the burning of waste materials, such as wood or agricultural residue, for the cogeneration of heat and electricity in stream-driven generators. Biomass burning is the primary and most proven waste-to-energy technology; other methods include high-temperature gasification and anaerobic digestion. Biomass applications utilizing waste products can help resolve waste disposal problems, a feature unique to this renewable energy category.

Biomass fuels provided approximately 5 percent of the energy used in the United States in 2015. Of that 5 percent, approximately 43 percent was from wood and wood-derived biomass, 46 percent was from biofuels (mainly ethanol), and 11 percent was from municipal waste (USEIA 2016). The total biomass energy consumed in the United States in 2016 was 353 trillion British thermal units in the residential sector and 136 trillion British thermal units in the commercial sector (USEIA 2017c).

Municipal solid waste (MSW) is burned at special waste-to-energy plants that use the heat to make steam to generate electricity or to heat buildings. In 2013, approximately 80 waste-to-energy plants in the United States generated electricity or produced steam. These plants burned approximately 30 million tons of MSW in 2013, and generated nearly 14 billion kilowatt hours of electricity, about the same amount used by 1.3 million U.S. households in 2013. The biogenic material in MSW contributed approximately 52 percent of the energy from MSW that was burned in electricity-generating waste-to-energy facilities (USEIA 2017d).

Analysis

Availability of feedstock, requirements for emissions control, and waste disposal represent the biggest challenges for biomass projects. To construct and operate a biomass system, a steady source of fuel would need to be identified. Kirtland AFB conducts many operations and activities that generate solid waste, including training, industrial, commercial, residential, administrative, and recreational operations. In 2016, Kirtland AFB generated 1,700 tons of MSW and 12,000 tons of construction and demolition debris (Wheelock 2017). A small incinerator typically burns approximately 100 tons daily, and also has contract mechanisms in place to ensure a sufficient supply stream to operate efficiently. Failure to meet stated minimums typically results in financial penalties.

Biomass as a source for generating renewable energy electricity is compatible with the mission and land use at Kirtland AFB. It is a mature technology that generally does not occupy as large a footprint as other technologies being considered, so it is feasible to implement. While biomass meets most of the Level 1 selection standards, the volume of solid waste generated at Kirtland AFB is inadequate to make such a project feasible at this time. Therefore, use of biomass is not suitable for use at Kirtland AFB and is dismissed from further consideration.

2.5 Comparative Summary of Renewable Energy Technologies

Table 2-1 contains a summary of the analysis for the four renewable energy technologies considered and the resultant conclusions. Two renewable energy technologies (i.e., SPV and geothermal energy) will be carried forward for further analysis.

Table 2-1. Summary of Renewable Energy Technology Analysis

Category	Summary of Analysis	Conclusion
Solar Photovoltaic	SPV technology meets the purpose of and need for the Proposed Action. It is a mature technology, compatible with the mission of the installation, readily available, and cost effective.	Meets purpose and need and is therefore carried forward for further analysis.
Wind Energy	Kirtland AFB lacks sufficient unconstrained land for a wind turbine farm. Vibrations from turbines are incompatible with certain activities on Kirtland AFB. Wind energy is not compatible with the mission or overall land use plan at Kirtland AFB.	Not carried forward for further analysis.
Geothermal Energy	Kirtland AFB has shown potential signs of geothermal activity. Geothermal is compatible with the mission and land use at Kirtland AFB. It is also a mature technology that would not occupy a large footprint.	Meets purpose and need and is therefore carried forward for further analysis.
Biomass (Waste-to-Energy)	Biomass is compatible with the mission and land use at Kirtland AFB. It is also a mature technology that would not occupy a large footprint, relative to other technologies considered. Kirtland AFB meets most of the criteria necessary to support a biomass project, but the volume of solid waste generated by Kirtland AFB is inadequate to make such a project feasible at this time.	Not carried forward for further analysis.

2.6 Identification of the Preferred Alternative

The Preferred Alternative is the Proposed Action via programmatic implementation of SPV and geothermal energy technologies, as described in **Sections 2.1**, **2.4.1**, and **2.4.3** and **Table 2-1**. Although specific projects have not been selected or designed, it is likely that some of the proposed projects would be on undeveloped land. Implementation of SPV technology, either as an array or as a rooftop/carport system, is feasible at a number of locations at Kirtland AFB, both in undeveloped areas and in the cantonment area. Implementation of geothermal technology would depend on determining if an adequate geothermal source exists on the installation.

This page intentionally left blank.

3. References

AWEA 2016	American Wind Energy Association (AWEA). 2016. U.S. Wind Industry Fourth Quarter 2016 Market Report, 26 January 2017. Available at: <*http://awea.files.cms-plus.com/FileDownloads/pdfs/4Q2016%20AWEA%20Market%20Report%20Public%20Version.pdf*>*.* Accessed 15 February 2017.
CPV Consortium 2017	CPV Consortium. 2017. CPV Technology. Available at: <*http://cpvconsortium.org/*>. Accessed 27 February 2017.
DOE 2017	U.S. Department of Energy (DOE). 2017. Energy Saver. Grid-Connected Renewable Energy Systems. Available at: <*https://energy.gov/energysaver/grid-connected-renewable-energy-systems*>. Accessed 27 February 2017.
Energy.gov 2013	Energy.gov. 2013. Office of Energy Efficiency & Renewable Energy. Solar Water Heater Basics. Available at: <*https://energy.gov/eere/energybasics/articles/solar-water-heater-basics*>. Last updated 19 August 2013.
Geothermal Energy Association 2016	Geothermal Energy Association. 2016. Annual U.S. & Global Geothermal Power Production Report, March 2016. Available at: *<http://geo-energy.org/reports/2016/2016%20Annual%20US%20Global%20Geothermal%20Power%20Production.pdf>.* Accessed 15 March 2017.
KAFB 2012a	Kirtland Air Force Base (KAFB). 2012. Integrated Natural Resources Management Plan For Kirtland Air Force Base. Final Year Revision-October 2012.
KAFB 2012b	KAFB. 2012. Kirtland Air Force Base Real Estate Management Existing Facilities.
KAFB 2015	KAFB. 2015. Department of the Air Force. Kirtland Air Force Base Environmental Commitment Statement. 11 September 2015. Available at: <*http://www.kirtland.af.mil/Portals/52/documents/AFD-151216-022.pdf?ver=2016-06-27-120822-140*>. Accessed 23 February 2017.
KAFB 2016	KAFB. 2016. Installation Development Plan. Kirtland Air Force Base, New Mexico. March 2016.
Keele University 2005	Keele University. 2005. Microseismic and Infrasound Monitoring of Low Frequency Noise and Vibrations from Windfarms. Professor Peter Styles, Dr. Ian Simpson, Mr. S. Toon, Mr. R. England, Mr. M. Wright. Available at: <*https://www.keele.ac.uk/geophysics/appliedseismology/wind/Final_Report.pdf*>. Accessed 15 March 2017.

National Wind Watch 2017 — National Wind Watch. 2017. Presenting the FAQs about Industrial Wind Power. Available at: <*https://www.wind-watch.org/faq-size.php*>. Accessed 15 March 2017.

NREL 2009 — National Renewable Energy Laboratory (NREL). 2009. Technical Report NREL/TP-6A2-45834. August 2009. *Land-Use Requirements of Modern Wind Power Plants in the United States.* Paul Denholm, Maureen Hand, Maddalena Jackson, and Sean Ong. Available at: <*https://www.nrel.gov/docs/fy09osti/45834.pdf*>. Accessed 5 September 2017.

NREL 2016 — NREL. 2016. Best Practices in PV System Operations and Maintenance 2nd Edition, December 2016. Available at: <*https://www.nrel.gov/docs/fy17osti/67553.pdf*>. Accessed 5 March 2017.

USAF 2010 — U.S. Air Force (USAF). 2010. Air Force Energy Plan. 2010. Available at: <*http://www.acc.af.mil/Portals/92/Docs/AFD-100930-035.pdf*>. Accessed 15 March 2017.

USEIA 2016 — U.S. Energy Information Administration (USEIA). 2016. Biomass Explained. Available at: <*https://www.eia.gov/energyexplained/?page=biomass_home*>. Last updated 15 June 2016.

USEIA 2017a — USEIA. 2017. Electricity Data Browser. Available at: <*https://www.eia.gov/electricity/data/browser/#/topic/0?agg=2,0,1&fuel=vtvv&geo=g&sec=g&linechart=ELEC.GEN.ALL-US-99.A~ELEC.GEN.COW-US-99.A~ELEC.GEN.NG-US-99.A~ELEC.GEN.NUC-US-99.A~ELEC.GEN.HYC-US-99.A~ELEC.GEN.WND-US-99.A~ELEC.GEN.TSN-US-99.A&columnchart=ELEC.GEN.ALL-US-99.A~ELEC.GEN.COW-US-99.A~ELEC.GEN.NG-US-99.A~ELEC.GEN.NUC-US-99.A~ELEC.GEN.HYC-US-99.A~ELEC.GEN.WND-US-99.A&map=ELEC.GEN.ALL-US-99.A&freq=A&ctype=linechart&ltype=pin&rtype=s&maptype=0&rse=0&pin=*>. Accessed 21 August 2017.

USEIA 2017b — USEIA. 2017. Independent Statistics & Analysis. U.S. electric generating capacity increase in 2016 was largest net change since 2011. Available at: <*http://www.eia.gov/todayinenergy/detail.php?id=30112*>. Accessed 27 February 2017.

USEIA 2017c — USEIA. 2017. Renewable Energy Consumption: Residential and Commercial Sectors. August 2017. Available at: <*https://www.eia.gov/totalenergy/data/monthly/pdf/sec10_4.pdf>.* Accessed 21 August 2017.

USEIA 2017d — USEIA. 2017. Waste-to-Energy (Municipal Solid Waste). Available at: <*https://www.eia.gov/energyexplained/index.cfm?page=biomass_waste_to_energy*>. Last updated 11 January 2017.

Wheelock 2017 Wheelock, Katrina, Hazardous/Solid Waste Program Manager. 2017. Kirtland AFB. Personal communication. 10 February 2017.

WBDG 2016 Whole Building Design Guide, National Institute of Building Sciences (WBDG). 2016. *Solar Ventilation Air Preheating*. Available at: <*https://www.wbdg.org/resources/solar-ventilation-air-preheating*>. Last updated 15 November 2016.

This page intentionally left blank.

A

Agency Coordination and Public Involvement

AGENCY DISTRIBUTION LIST

Federal, State, and Local Agencies

Regional Director
US Fish & Wildlife Service
Southwest Regional Office
PO Box 1306
Albuquerque NM 87103-1306

Mr. Bill Walker, Regional Director
Bureau of Indian Affairs
Southwest Regional Office
1001 Indian School Road NW
Albuquerque NM 87104

Ms. Danita Burns, District Manager
Bureau of Land Management
New Mexico State Office
Albuquerque District Office
Pan American Building
100 Sun Avenue NE, Suite 330
Albuquerque NM 87109-4676

Ms. Jennifer Faler, Area Manager
Bureau of Reclamation
Albuquerque Area Office
555 Broadway NE, Suite 100
Albuquerque NM 87102-2352

Mr. Stephen Spencer, Regional
Environmental Officer
US Department of Interior
Office of Environmental Policy &
Compliance - Albuquerque Region
1001 Indian School Road NW, Suite 348
Albuquerque NM 87104

Mr. Kelvin L. Solco, Regional Administrator
Federal Aviation Administration
Southwest Region
10101 Hillwood Parkway
Fort Worth TX 76177-1524

Ms. Pearl Armijo, District Conservationist
Natural Resources Conservation Service
Albuquerque Service Center
6200 Jefferson Street NE
Albuquerque NM 87109-3434

Mr. George Macdonnell, Chief
Environmental Resources Section
US Army Corps of Engineers
4101 Jefferson Plaza NE
Albuquerque NM 87109

Mr. Samuel Coleman, P.E.
Acting Regional Administrator
US Environmental Protection Agency,
Region 6
1445 Ross Avenue, Suite 1200
Dallas TX 75202-2733

Ms. Cheryl Prewitt, Regional Environmental
Coordinator
US Forest Service
Southwestern Region
333 Broadway Boulevard SE
Albuquerque NM 87102-3407

Ms. Susan Lacy
DOE/NNSA Sandia Field Office
PO Box 5400
Albuquerque NM 87187

Mr. John Weckerle
DOE/NNSA Office of General Counsel
PO Box 5400
Albuquerque NM 87187

The Honorable Martin Heinrich
US Senate
400 Gold Avenue SW, Suite 1080
Albuquerque NM 87102

The Honorable Tom Udall
US Senate
400 Gold Avenue SW, Suite 300
Albuquerque NM 87102

The Honorable Steve Pearce
US House of Representatives
3445 Lambros Loop NE
Los Lunas NM 87031

The Honorable Michelle Lujan Grisham
US House of Representatives
400 Gold Avenue SW, Suite 680
Albuquerque NM 87102

The Honorable Ben R. Luján
US House of Representatives
1611 Calle Lorca, Suite A
Santa Fe NM 87505

Dr. Jeff Pappas, PhD, State Historic Preservation Officer and Director
New Mexico Historic Preservation Division
Department of Cultural Affairs
Bataan Memorial Building
407 Galisteo Street, Suite 236
Santa Fe NM 87501

Mr. Aubrey Dunn
Commissioner of Public Lands
New Mexico State Land Office
310 Old Santa Fe Trail
Santa Fe NM 87501

Mr. Matt Wunder, Chief
Conservation Services
New Mexico Department of Game and Fish
PO Box 25112
Santa Fe NM 87504

Mr. Clyde Ward, Assistant Commissioner for Commercial Resources
New Mexico State Land Office
PO Box 1148
Santa Fe NM 87504

Ms. Jennifer L. Hower
Office of General Counsel & Environmental Policy
New Mexico Environment Department
1190 St. Francis Drive, Suite N4050
Santa Fe NM 87505

Mr. Jeff M. Witte, Director/Secretary
New Mexico Department of Agriculture
3190 S. Espina
Las Cruces NM 88003

Mr. Ken McQueen, Cabinet Secretary-Designate
New Mexico Energy, Minerals and Natural Resources Department
1220 South St. Francis Drive
Santa Fe NM 87505

Development Management/Department Director
Bernalillo County Planning Section
111 Union Square SE, Suite 100
Albuquerque NM 87102

Department Director
City of Albuquerque Planning Department
PO Box 1293
Albuquerque NM 87103

Board of Directors
Mid-Region Council of Governments
809 Copper Avenue NW
Albuquerque NM 87102

Ms. Julie Morgas Baca
Bernalillo County Manager
Bernalillo County Manager's Office
One Civic Plaza NW, 10th Floor
Albuquerque NM 87102

Ms. Rhiannon Samuel
Director of Communications
City of Albuquerque Office of the Mayor
PO Box 1293
Albuquerque NM 87103

Bernalillo County Board of Commissioners
One Civic Plaza NW, 10th Floor
Albuquerque NM 87102

Albuquerque City Councilmembers
One Civic Plaza NW, 9th Floor, Suite 9087
Albuquerque NM 87102

Mr. Jerry Lovato, Executive Engineer
Albuquerque Metropolitan Arroyo Flood Control Authority
2600 Prospect Avenue NE
Albuquerque NM 87107

Native American Tribes

Governor Kurt Riley
Pueblo of Acoma
PO Box 309
Acoma Pueblo NM 87034

Governor Eugene Herrera
Pueblo of Cochiti
PO Box 70
Cochiti Pueblo NM 87072

Chairman Herman G. Honanie
Hopi Tribal Council
PO Box 123
Kykotsmovi AZ 86039

Governor J. Robert Benavides
Pueblo of Isleta
PO Box 1290
Isleta NM 87022

President Wainwright Velarde
Jicarilla Apache Nation
PO Box 507
Dulce NM 87528

Governor Virgil A. Siow
Pueblo of Laguna
PO Box 194
Laguna NM 87026

President Danny H. Breuninger, Sr.
Mescalero Apache Tribe
PO Box 227
Mescalero NM 88340

Governor Phillip A. Perez
Pueblo of Nambe
Route 1 Box 117-BB
Santa Fe NM 87506

President Russell Begaye
Navajo Nation
PO Box 7440
Window Rock AZ   86515

Governor Peter Garcia, Jr.
Ohkay Owingeh Pueblo
PO Box 1099
San Juan Pueblo NM 87566

Governor Craig Quanchello
Pueblo of Picuris
PO Box 127
Peñasco NM 87553

Governor Joseph M. Talachy
Pueblo of Pojoaque
78 Cities of Gold
Santa Fe NM 87506

Governor Malcom Montoya
Pueblo of Sandia
481 Sandia Loop
Bernalillo NM 87004

Governor Anthony Ortiz
Pueblo of San Felipe
PO Box 4339
San Felipe Pueblo NM 87001

Governor James R. Mountain
Pueblo of San Ildefonso
02 Tunyo Po
Santa Fe NM 87506

Governor Lawrence Montoya
Pueblo of Santa Ana
2 Dove Road
Santa Ana Pueblo NM 87004

Governor J. Michael Chavarria
Pueblo of Santa Clara
PO Box 580
Española NM 87532

Governor Robert B. Coriz
Pueblo of Santo Domingo
PO Box 99
Santo Domingo Pueblo NM 87052

Governor Ruben Romero
Pueblo of Taos
PO Box 1846
Taos NM   87571

Governor Mark Mitchell
Pueblo of Tesuque
Route 42 Box 360-T
Santa Fe NM 87506

Chairman Ronnie Lupe
White Mountain Apache Tribe
PO Box 700
Whiteriver AZ 85941

Governor Carlos Hisa
Ysleta del Sur Pueblo
117 S Old Pueblo Road
PO Box 17579
El Paso TX 79907

Governor Carl B. Schildt
Pueblo of Zia
135 Capitol Square Drive
Zia Pueblo NM 87053-6013

Governor Val R. Panteah, Sr.
Pueblo of Zuni
PO Box 339
Zuni NM 87327

Chairman E. Paul Torres
All Pueblo Council of Governors
2401 12th Street NW
Albuquerque NM 87103

Executive Director Joshua Madalena
Five Sandoval Indian Pueblos, Inc.
4321 Fulcrum Way NE, Suite B
Rio Rancho NM 87144

Executive Director Gilbert Vigil
Eight Northern Indian Pueblos Council, Inc.
327 Eagle Drive
PO Box 969
Ohkay Owingeh NM 87566

Speaker Pro Tem LoRenzo Bates
23rd Navajo Nation Council, Office of the Speaker
PO Box 3390
Window Rock AZ 86515

Repositories

San Pedro Library
5600 Trumbull Ave SE
Albuquerque NM 87108