DOE OFFICE OF INDIAN ENERGY

Potential for Renewable Energy Development on Tribal Lands

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U.S. DEPARTMENT OF ENERGY | Office of Indian Energy

ICF INTERNATIONAL

Introduction

- The DOE Office of Indian Energy Policy and Programs (OI) requested ICF International (ICF) to identify areas within Tribal Lands that have a strong potential for renewable energy generation (solar and wind) as a source of Tribal revenue within the geographic area covered by the Western Electric Coordination Council (WECC) transmission grid
- ICF used a combination of geospatial modeling and power flow modeling to identify sites where:
  - Conditions are optimal for solar or wind generation
  - Access to high-voltage transmission lines is favorable
  - Transmission upgrade costs would be minimal

Geospatial Analysis

Phase I: Identify Potential Sites

- Obtained GIS layers (e.g., wind/solar resources, transmission lines/substations, Tribal Lands, wetlands)
- Identify Tribal Lands that intersect with areas that are highly suitable for wind and solar generation
  - 4.5 kWh/m^2/day and above for solar
  - Wind Power Class (WPC) 3 and above for wind (50 meters)
- Exclude areas that would not be suitable for commercial development (e.g., wetlands, forested areas, towns)
- Identify areas within Tribal Lands that meet the minimum size for commercial viability and are relatively flat (construction costs are lower)
  - Solar: minimum 42 acres, no more than 5% slope
  - Wind: minimum 2,500 acres, no more than 10% slope

Geospatial Analysis (ctd.)

Phase II: Identify most Promising Sites

- Conduct a least-cost path analysis to identify the 25 lowest-cost sites closest to any high-voltage WECC transmission line
  - Connect to substation with minimum 35kV
  - Use Least-cost path for connection:
    - Divide area into small polygons
    - Assign a "cost factor" to each polygon based on its geographic features (e.g., slope, land, wetland), characteristics (e.g., existing right-of way on a road), while avoiding known sensitive areas (e.g., parks)
    - Find the "least cost" path based on the sum of all "cost factors" in all polygons in the path
    - Rank by cost per acre (could rank using other metrics such as total cost or cost per mile)
  - Consider existing and future (Foundational Projects) transmission lines
- No more than 3 sites per Tribal Land

Power Flow Modeling - Methods

- ICF performed a detailed power flow assessment for the top 25 solar sites and 24 wind sites (selected from the GIS analysis) to assess the ease of interconnection to the grid and the ability to dispatch from the site without violating transmission reliability criteria
- Using the GE PSLF power flow model, ICF examined the system operation under normal and emergency conditions and determined if dispatch from the site would cause thermal or voltage violations under steady state conditions
  - **Base Case**: ICF modeled the entire Western Interconnection, without any power injection from wind and solar farms, under normal (N-0) and contingency (N-1) conditions and recorded the substation voltages and power flows over the transmission lines and transformers (2015 selected to allow for appropriate lead times to develop the generation facilities)
  - **Scenario Cases**: ICF modeled 20 MW solar, 20 MW wind, and 100 MW wind power generation at the substations identified in the least-cost analysis; to compensate for the generation injection, ICF backed down existing generation in WECC proportionally
  - ICF monitored transmission line loadings and substation voltages to identify any line overloads or out-of-limit voltages under normal (N-0) and N-1 contingency conditions using the 2015 summer peak power flow case

Power Flow Modeling - Results

- At the 20 MW injection level (wind and solar), there were either minimal or no violations in the system. At 100 MW (wind), there were some thermal and voltage violations at several wind sites. However, all of these violations could be resolved either by proposed transmission upgrades in the western interconnection and other operating procedures used by system operators.
- This signifies that renewable generation facilities at the identified "top sites" could be developed with minimal transmission upgrade costs. However, radial connection from the generation facility to the transmission interconnection point would be the responsibility of the tribe and/or the developer.

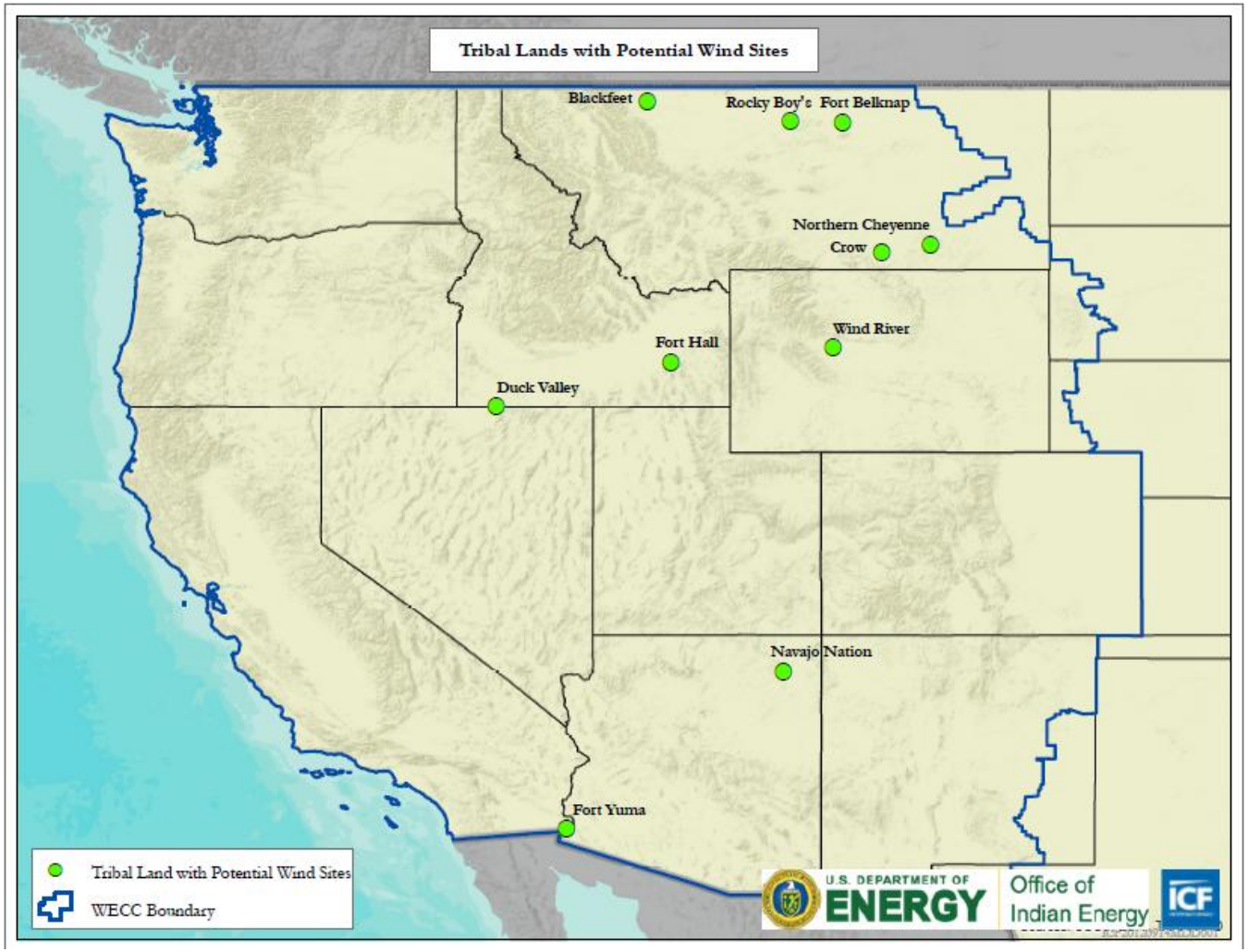
Results –Wind Sites

Tribal Land	No. Potential Sites
Blackfeet	95
Fort Belknap	50
Crow	21
Navajo Nation	8
Wind River	8
Northern Cheyenne	4
Duck Valley	2
Fort Hall	2
Fort Yuma	1
Rocky Boy's	1
	192

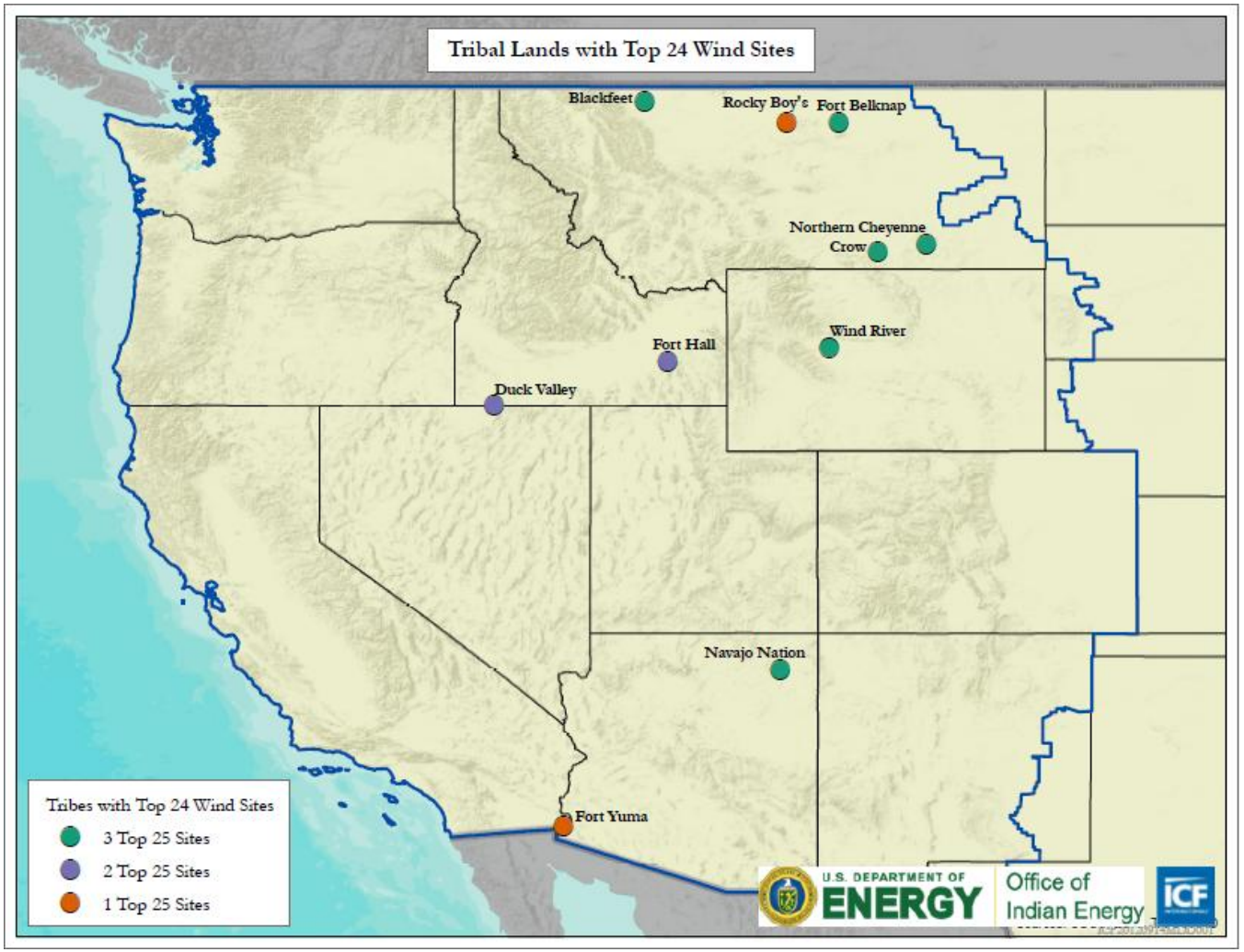
Tribal Land	No. Top Sites
Blackfeet	3
Crow	3
Fort Belknap	3
Northern Cheyenne	3
Wind River	3
Navajo Nation	3
Fort Hall	2
Duck Valley	2
Rocky Boy's	1
Fort Yuma	1
	24

- 192 potential sites were identified on 10 Tribal Lands
- The majority were on the Blackfeet, Fort Belknap, and Crow Lands
- 24 “top sites” were identified using least-cost methodology
- These sites were on all 10 Tribal Lands

Tribal Lands with Potential Wind Sites



Tribal Lands with Top 25 Wind Sites



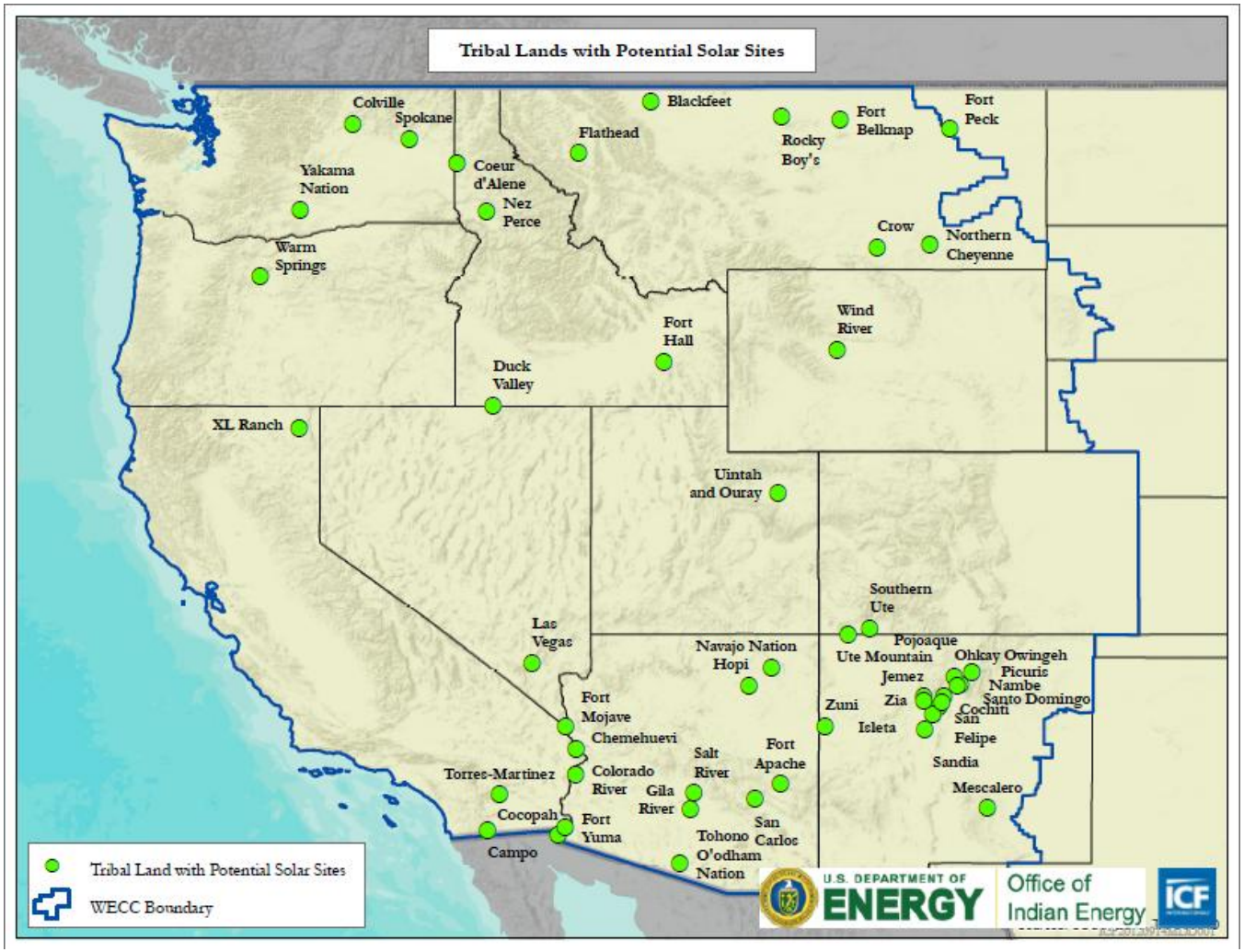
Results – Solar Sites

Tribal Land	No. Potential Sites	Tribal Land	No. Potential Sites	Tribal Land	No. Potential Sites
Navajo Nation	856	Fort Yuma	36	Zia	8
Wind River	314	Colville	34	Cocopah	7
Fort Hall	178	San Felipe	34	Tohono O'odham Nation	7
Crow	166	Nambe	25	Coeur d'Alene	6
Gila River	137	Warm Springs	22	Ohkay Owingeh	6
Blackfeet	134	Cochiti	17	Las Vegas	5
Flathead	102	Santo Domingo	17	Sandia	5
Nez Perce	87	Jemez	16	Torres-Martinez	5
Colorado River	82	Pojoaque	16	Picuris	3
Yakama Nation	63	Fort Belknap	13	Spokane	3
Salt River	60	Uintah and Ouray	13	XL Ranch	3
Isleta	50	Chemehuevi	12	Agua Caliente	2
Hopi	49	Fort Peck	12	Campo	2
Northern Cheyenne	45	Zuni	12	Cabazon	1
Rocky Boy's	42	Southern Ute	11	Fort Mojave	1
				San Carlos	1

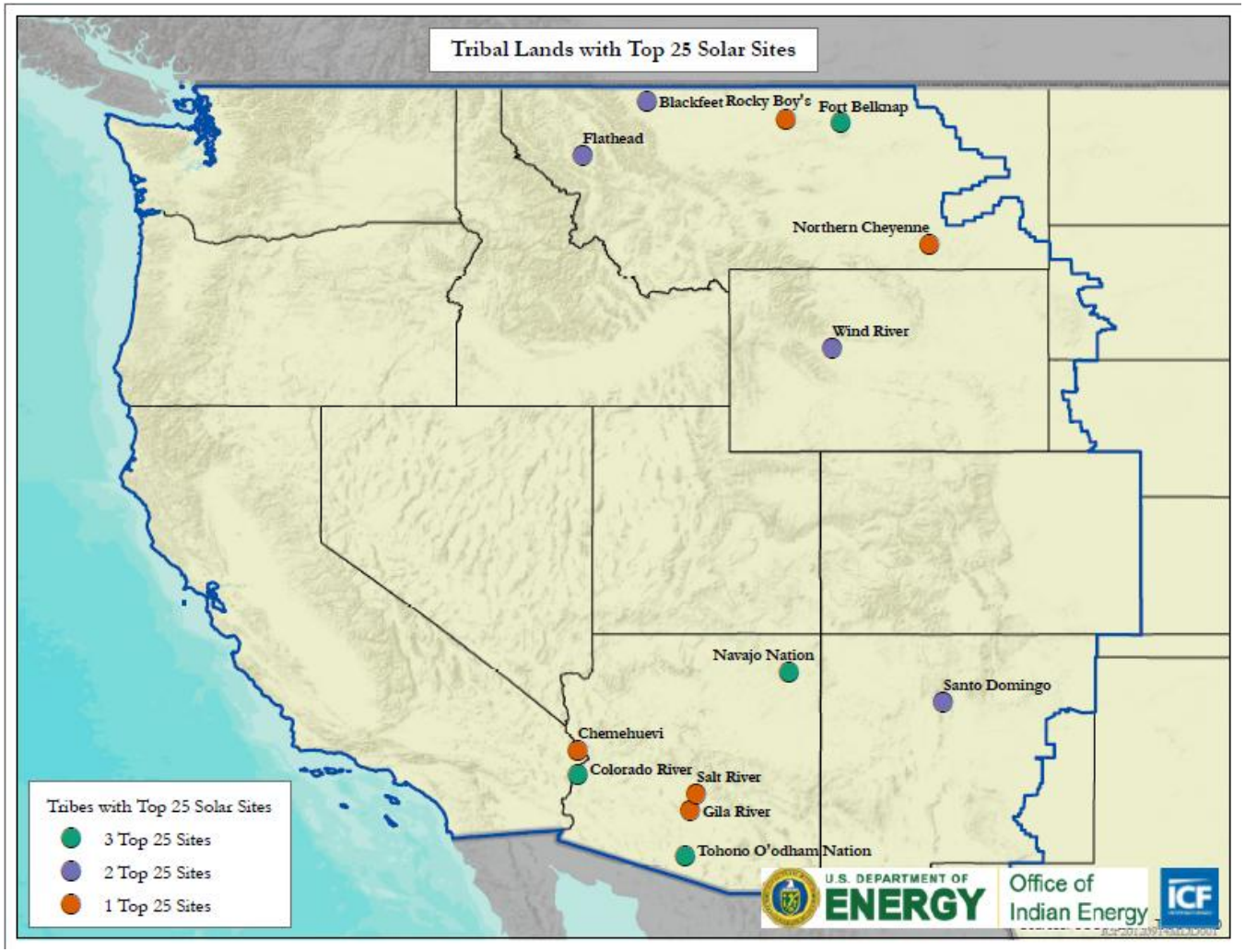
Total = 2,720 Potential Sites

- More than 26,000 potential sites were identified – to reduce this to a manageable number for analysis, we selected only those sites within 2 miles of a substation
- We subsequently identified 2,720 potential sites on 46 Tribal Lands
- Nearly 70% were on seven Lands: Navajo Nation, Wind River, Fort Hall, Crow, Gala River, Blackfeet, and Flathead

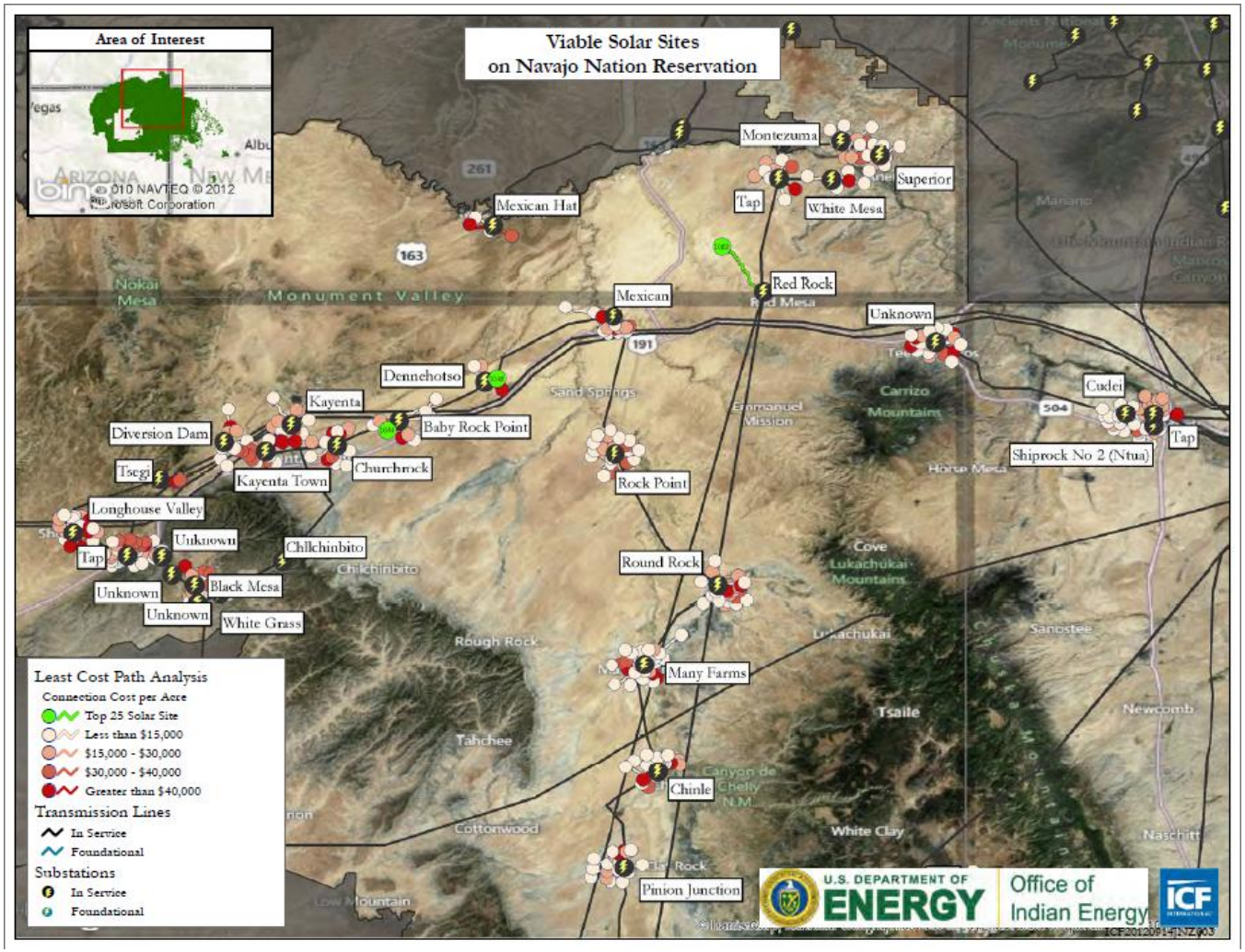
Tribal Lands with Potential Solar Sites



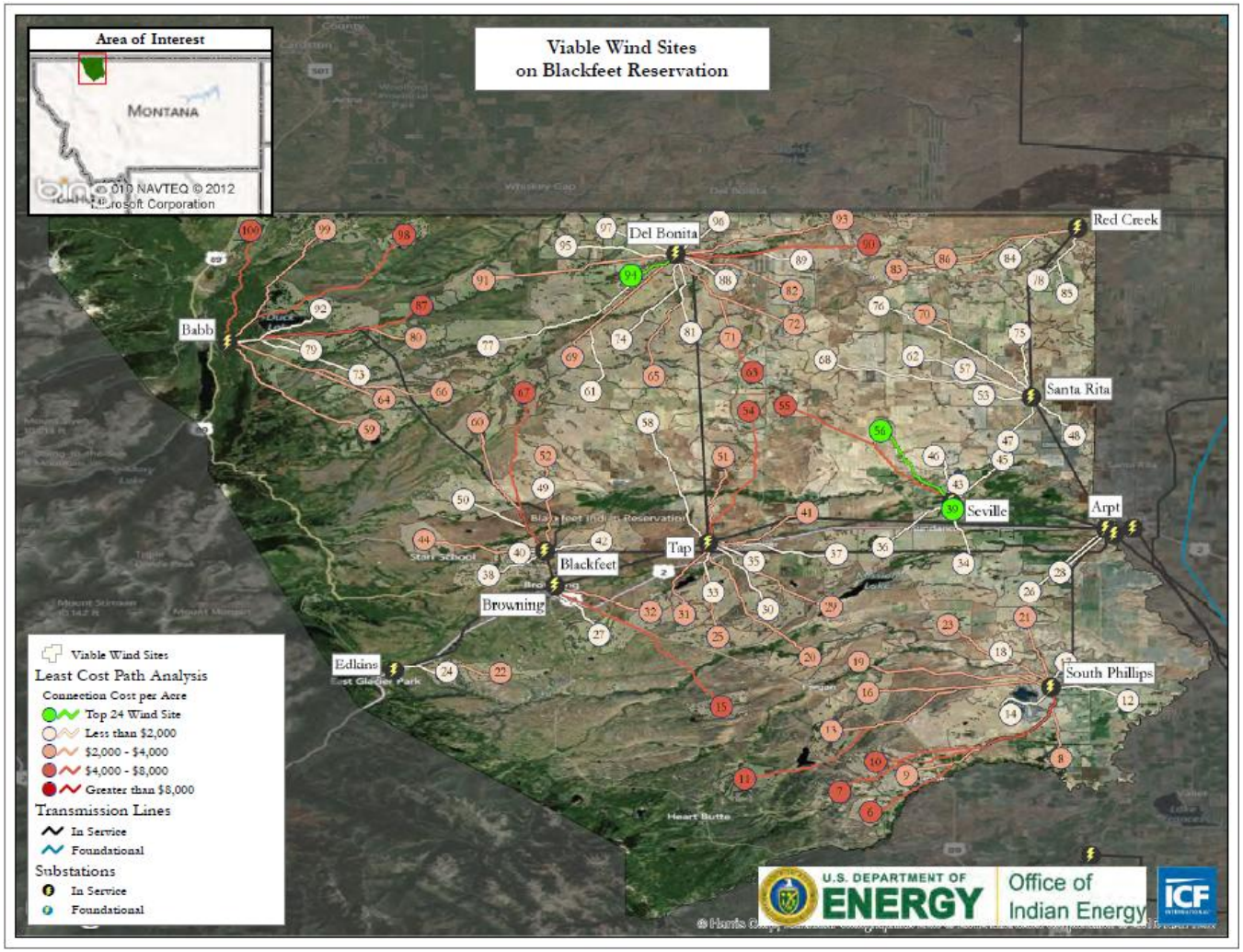
Tribal Lands with Top 25 Solar Sites



Detailed Maps – Solar Example



Detailed Maps – Wind Example



Discussion

- The “top sites” were identified using a high-level analysis with limited site-specific information. The maps provided by this analysis show other potential sites that might be more feasible if more detailed site-specific factors are considered.
- Costs are indicative costs based on an assumed100 MW voltage level facility interconnection and associated generic cost factors – actual costs could be higher or lower
- Costs do not consider factors such as potential upgrades to identified substations, transformers, financing or other engineering contingencies
- “Top Sites” would be different if we ranked on other factors (e.g., total cost) or changed wind class or solar resource cutoffs
- Power flow modeling analysis does not consider the impact of power injection simultaneously from multiple sites
- Although suitable wind sites are somewhat limited, there are hundreds of suitable solar sites on many Tribal Lands. These are not limited to the desert Southwest.
- Although the WECC Foundational projects were included in the analysis, none of the “top sites” were linked to these future transmission lines.
- While the power flow modeling indicates that there are no technical limitations for power transfers from the “top sites,” it is possible that firm contracts may already exist on certain transmission lines in the region indicating the unavailability of additional capacity.