Warm Springs Power & Water Enterprises

Wind Energy Development Feasibility Study

Warm Springs Indian Reservation
Oregon
Confederated Tribes of Warm Springs
Warm Springs, Oregon

US Department of Energy
Tribal Energy Program Review
October 23-27 2006

Project Participants

- **Warm Springs Power & Water Enterprises**
- **CTWS Dept. of Natural Resources**
- **DW McClain and Associates: Project Management**
- **OSU Energy Research Laboratory: Wind Modeling**
- **Elcon Associates: Transmission System Studies**
- **Northwest Wildlife Consultants: Biological Review**

Location of Study Areas:

- May 2003 – January 2005
- All sites are on Tribal Trust property
- Data Collected at Four Locations
  - Handley Ridge on the north boundary of the reservation.
  - Eagle Butte near the city of Warm Springs
  - Island Ridge near the center of the reservation
  - Mutton Mountain near the Kah Nee Ta Resort


STATE OF OREGON
The Columbia River
Portland
The Dalles
Pendelton
Maupin
Warm Springs Reservation of Oregon
Deschutes River
Salem
Madras
Prineville
Eugene
Bend
Ontario
Burns
Grants Pass
Klamath Falls
Lakeview

Mutton Mountain Evaluation

- Redeployment of Anemometers
  - All Towers Have Multiple Anemometer Elevations
- Mutton Mountain Tower Site #1
  - 50 Meter Tower Not Moved
  - Instrumented in May 2003
- Mutton Mountain Tower Sites #2
  - 30 Meter Tower
  - Instrumented in May 2005
- Mutton Mountain Tower Sites #3
  - 50 Meter Tower
  - Instrumented in May 2005
- Mutton Mountain Tower Sites #4
  - 50 Meter Tower
  - Instrumented in June 2005
- Mutton Mountain Tower Site #5
  - 30 Meter Tower
  - Instrumented in June 2005
- Shaniko Butte Area
  - 30 Meter Tower
  - Instrumented in June 2005
  - Site also provides regional wind data for Mutton Mountain site

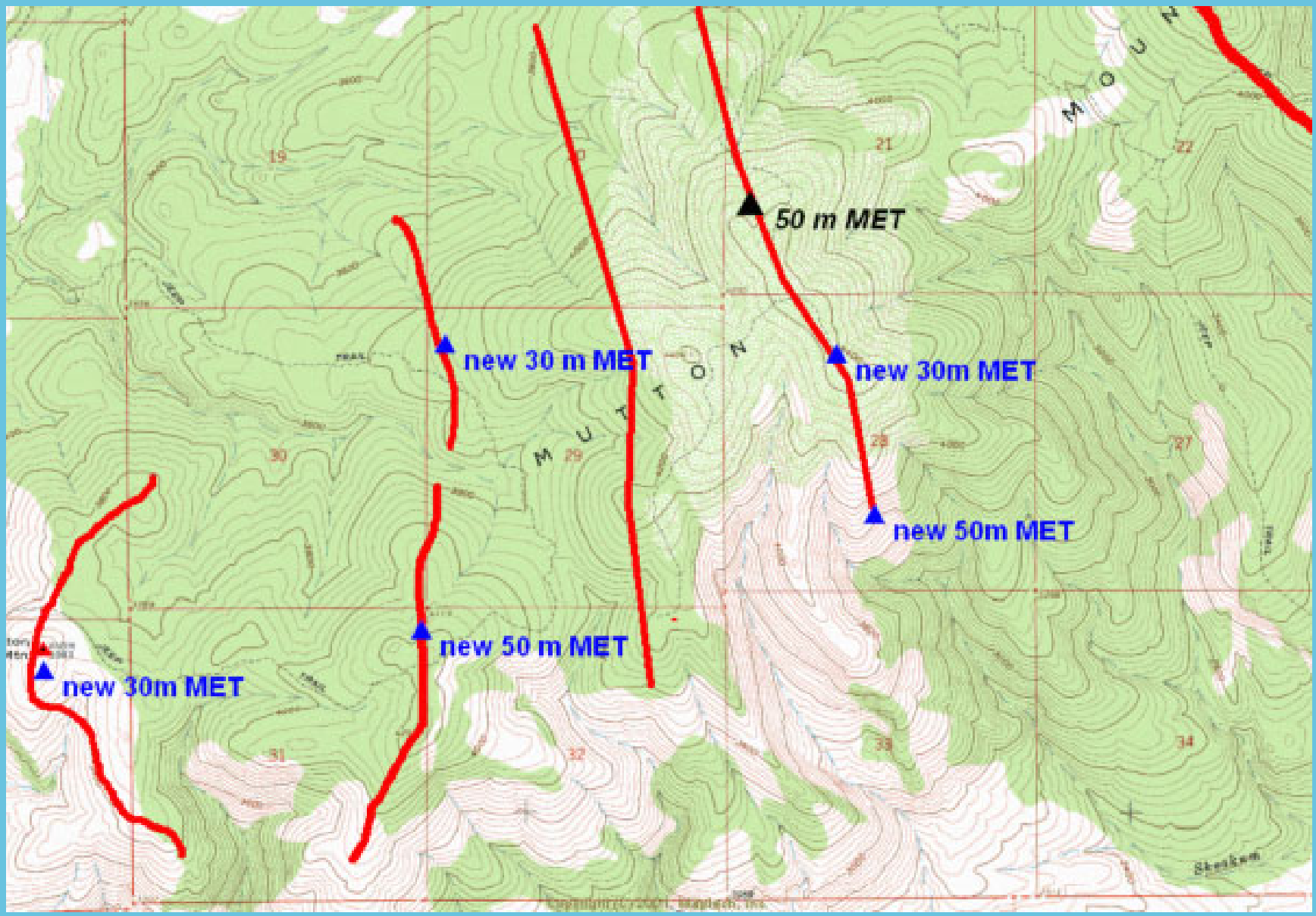
Mutton Mountain Site Characteristics

- Complex Mountainous Terrain
- Ridge Line Runs Northwest
- Compounded By North-South Ridges
- Elevations Between 3,800 and 4,400 feet
- MM Tower #1 Set at Highest Elevation
- 3 Years MM #1 Data Annual Ave. Wind Speed
  - 11.2 mph @ 10 Meters
  - 14.3 mph @ 30 Meters
  - 15.3 mph @ 50 Meters
- Dominate Wind Direction From West
  - West/Northwest in Summer
  - West/Southwest in Winter

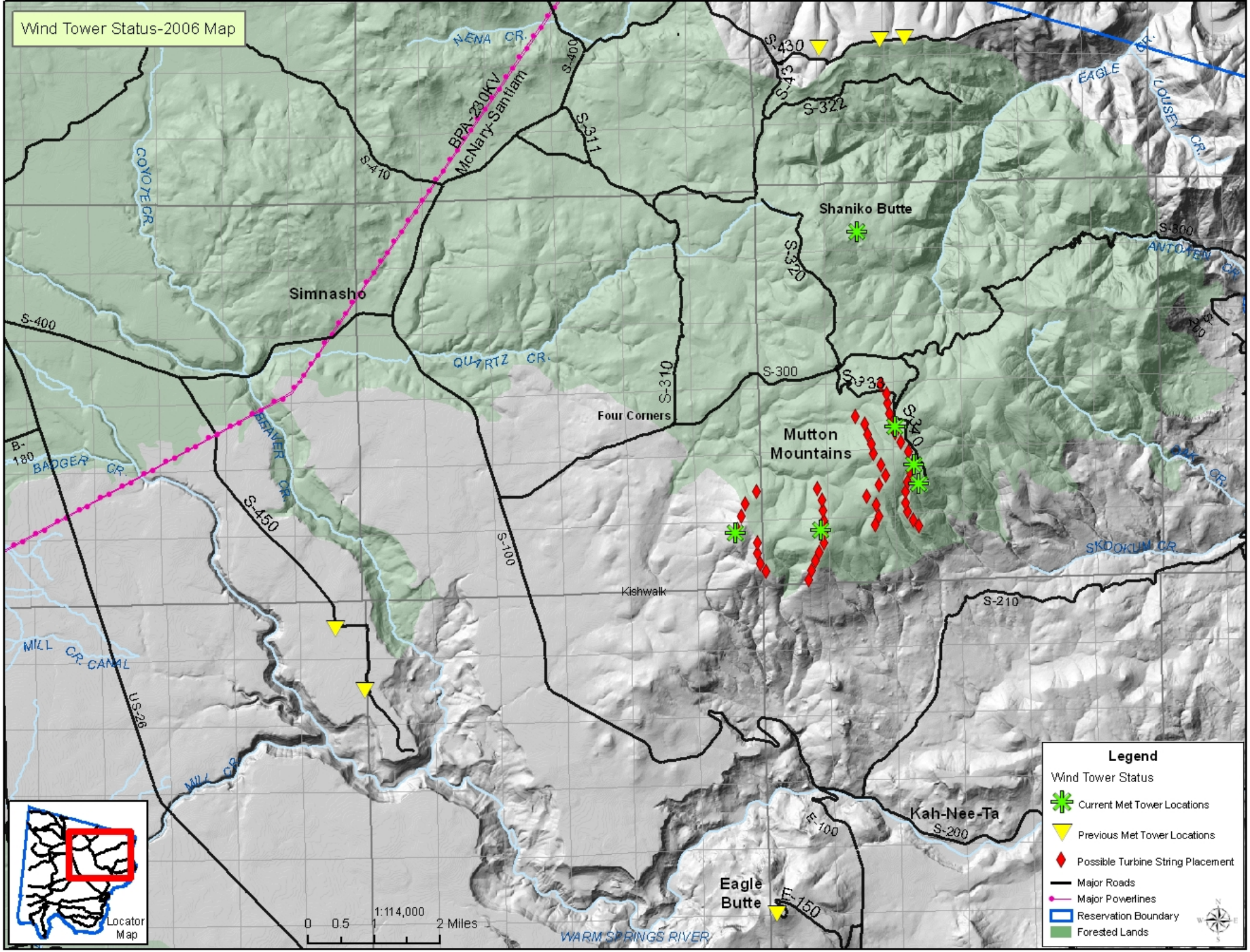
OSU Wind Energy Modeling

- **Average Wind Shear Coefficient:**
  - **Estimated To Be 0.134 (30m-49m)**
- **Wind Flow Model Results For Average Wind Speeds**
  - **11.9 mph @ 10 Meters**
  - **14.4 mph @ 30 Meters**
  - **15.3 mph @ 50 Meters**
  - **17.6 mph @ 100 Meters**
- **Actual Data Is Very Close To Modeling Predicted Results**
  - **11.2 mph @ 10 Meters**
  - **14.3 mph @ 30 Meters**
  - **15.3 mph @ 50 Meters**
- **Confidence Level Of Model Is High**
  - **Hub Height Wind Speeds**
  - **17.5 to 18.5 mph @ 100 Meters**

Area of Interest WithTree Flagging Signs


50 m MET
new 30 m MET
new 30m MET
new 50m MET
new 50 m MET
new 30m MET
MUTATON
MOUN

Ridgelines Identified For Potential Development


Wind Tower Status-2006 Map
NENA CR.
S-400
S-430
S-322
EAGLE CR.
LOUSET CR.
BPA-230KV
McNary-Santiam
S-311
S-410
COYOTE CR.
Shaniko Butte
S-300
ANTELOPE CR.
S-320
Simnasho
S-400
QUARTZ CR.
S-310
S-300
S-330
S-340
Four Corners
Mutton
Mountains
B-180
BADGER CR.
BEAVER CR.
S-450
S-100
SKDOKUM CR.
Kishwalk
S-210
MILL CR. CANAL
US-26
MILL CR.
E-100
Kah-Nee-Ta
S-200
Eagle
Butte
E-150
WARM SPRINGS RIVER
Locator
Map
0 0.5 1 2 Miles
1:114,000
Legend
Wind Tower Status
Current Met Tower Locations
Previous Met Tower Locations
Possible Turbine String Placement
Major Roads
Major Powerlines
Reservation Boundary
Forested Lands

Estimates of Installed Capacity

Model Uses Two Wind Turbines

- GE 1.5 MW
- GE 2.5 MW
- Power Curves Obtained From GE

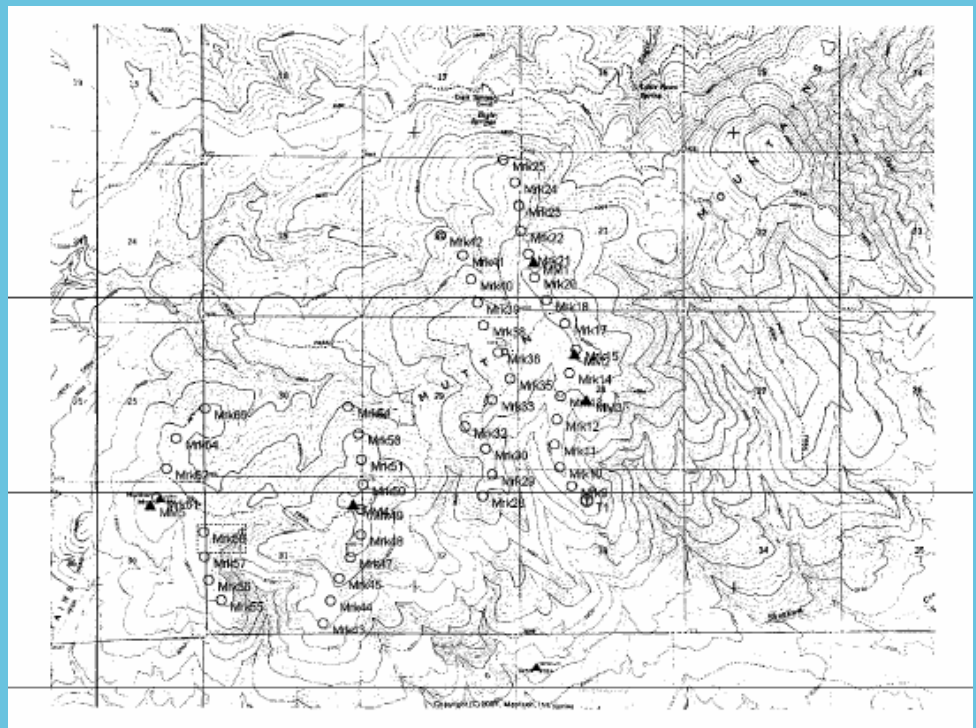
General Specifications

Specifications	GE 1.5 xle	GE 2.5 xl
Diameter(m)	82.5	100
Tower Height(m)	100	100
Rated Capacity(MW)	1.5	2.5
Cut-in wind speed (m/s)	3.5	3.5
Rated wind speed (m/s)	12.5	12.5
Cut-out wind speed (m/s)	20	25

Number of Turbines

Lateral Spacing

- **GE 1.5 MW - 3 diameter spacing**
- **GE 2.5 MW – 4 diameter spacing**
- **Four 2.5 MW turbines for every five 1.5 MW turbines in same area**



Installed Capacity Estimate

Ridge Number (E-W)	Gross Turbine Locations	Turbines (1.5 MW) Installed Capacity with 10% loss of locations	Turbines (2.5 MW) Installed Capacity with 10% loss of locations
1	16	21.0	27.5
2	12	16.5	20.0
3	10	13.5	17.5
4	8	10.5	15.0
Shaniko	9	12.0	17.5
Totals	46	73.5	97.5

Capacity Factor

Table 10. Net average wind farm capacity factors (reduced ~21% or 22% for losses and inter-annual variability) from Table 7 for Ridges 1 and 2.

Site	Turb #	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Ave
GE 1.5 MW	25	0.33	0.28	0.30	0.26	0.21	0.37	0.37	0.46	0.40	0.28	0.27	0.29	0.32
GE 2.5 MW	19	0.30	0.25	0.27	0.23	0.18	0.33	0.34	0.43	0.37	0.25	0.24	0.25	0.29

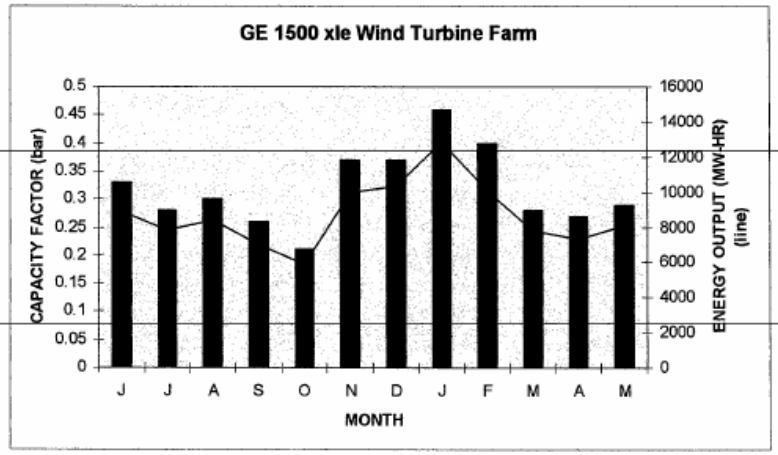
Table 11. Net average wind farm capacity factors (reduced ~21% or 22% for losses and inter-annual variability) from gross wind farm capacity factors for different development inclusions.

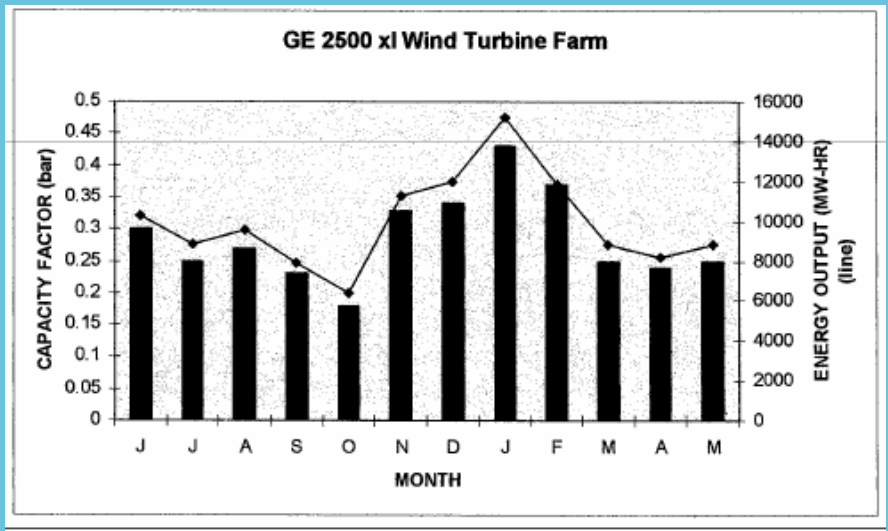
Sites	1.5 MW (# turbines)	2.5 MW(# turbines)
Ridge 1,2	0.32 (25)	0.29 (19)
Ridge 1,2,3	0.30 (34)	0.30 (25)
Ridge 1,2,3,4	0.29 (41)	0.29 (31)
Ridge 1,2,3,4 & Shaniko	0.29 (49)	0.29 (39)

Capacity Factor By Month

Figure 8. Monthly variation in capacity factor and energy output in MW-hr (a) using GE 1500 xle wind turbines (b) using GE 2500 xl wind turbines for ridges 1 and 2 of Mutton Mountains.

(a)





Annual Energy Production Estimate

- GE 1.5 MW Turbine
- Power = (1500 kW) (25 Turbines) (.32 capacity factor) (8760 hr/yr)
- 105,120,200 kW-hr or 105,120 MW-hr per year

- Revenue Estimate
- @ $0.07/kW-hr
- $7,358,000 per year

- GE 2.5 MW Turbine
- Power = (2500 kW) (25 Turbines) (.32 capacity factor) (8760 hr/yr)
- 120,669,000 kW-hr or 120,669 MW-hr per year

- Revenue Estimate
- @ $0.07/kW-hr
- $8,446,830 per year

Other Studies:

Environmental Study:

- **Preliminary reconnaissance completed**
- **Area is not a major raptor area**
- **No Threaten and Endangered Species found in area**

Transmission Interconnection Study:

- **Nearest Transmission Lines**
- **69 kV line 8 miles south of project**
  - **Wasco Electric (REA)**
- **230 kV line 8 miles north and west of project**
  - **Bonneville Power Administration**
- **Multiple Options Under Study**

Road Access Study:

- **Main access road into the area is adequate**
- **Existing roads to turbine sites are limited**
  - **Older logging haul roads, not all weather**
  - **Older logging spur roads, not enough turning radius**
  - **No roads to several sites, jeep trails**

Studies & Activities to Begin

- **Finalize report to DOE**
- **Report conclusions to WSPWE BOD & Tribal Council**
- **Obtain funding source for next steps**
- **Install additional met tower site, on ridgeline north of existing met sites**
- **Environmental Study:**
  1. **More detailed surveys required**

Transmission Interconnection:

- **Determine best connection for resource**
- **Road Access Study:**
- **Determine what routes are best for development**
- **What access roads into the area are adequate**

Economic modeling

- **Begin discussions with outside potential partners**

Conclusion:

- **Mutton Mountain Area Is The Best Site With Potential For Wind Energy Development.**
- **Tribal Council supports and request we advance this study and report back what conclusions and recommendations we have for development.**
- **Keeping energy team informed and involved**
- **Engage community & committees**