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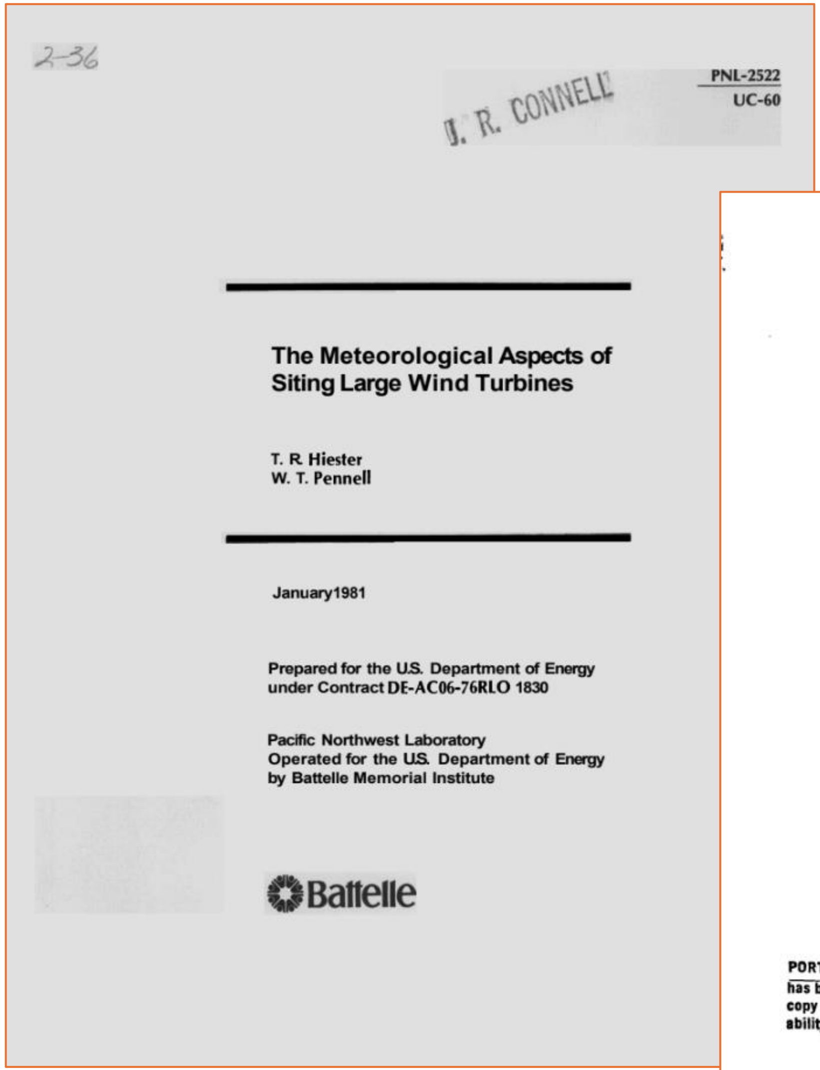

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PNL-2522
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The Meteorological Aspects of Siting Large Wind Turbines

T. R. Hiester
W. T. Pennell

January 1981

Prepared for the U.S. Department of Energy under Contract DE-AC06-76RLO 1830

Pacific Northwest Laboratory
Operated for the U.S. Department of Energy
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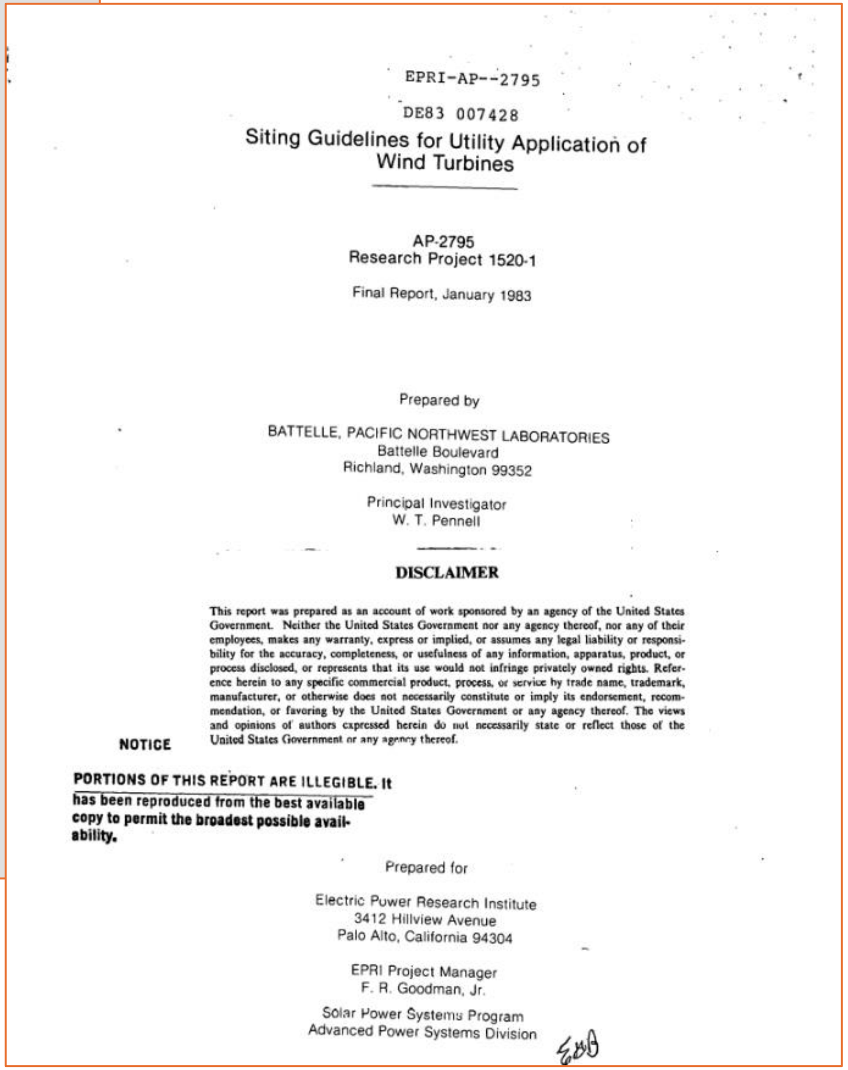
1983



EPRI-AP--2795

DE83 007428

Siting Guidelines for Utility Application of Wind Turbines

AP-2795
Research Project 1520-1

Final Report, January 1983

Prepared by

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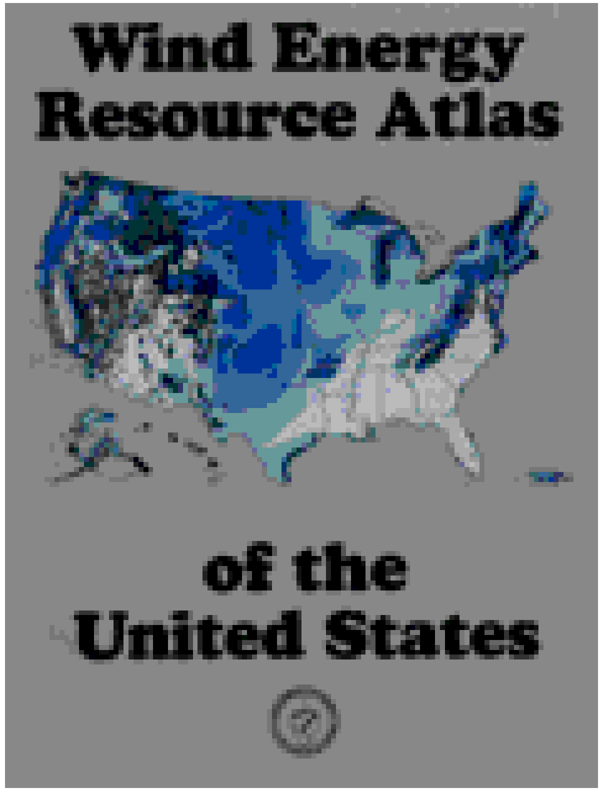

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CONTENTS

Wakes – Lissaman's model

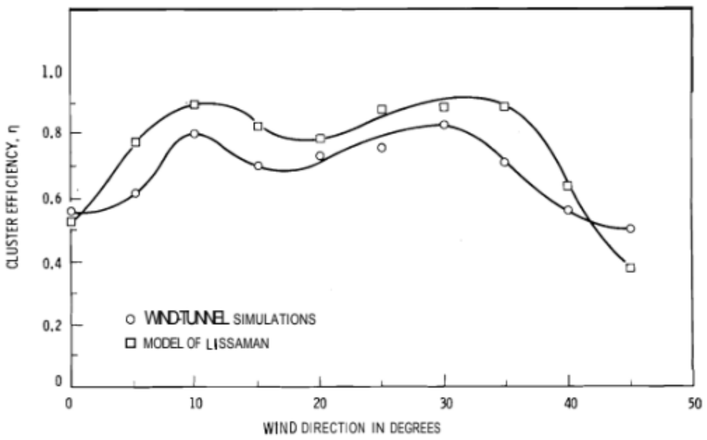

FIGURE-9.15. Cluster Efficiency as a Function of Wind Direction. The model array consists of staggered rows of wind turbine with rows being 4 diameters apart. Therefore machine spacing for 0° and 90° wind directions is 8 diameters and is 5.7 diameters for a wind direction of 45°. Forty-nine tea-strainers were used in the physical model (Builtjes 1979).

TABLE 9.2. A Procedure for Cluster Design and Performance Evaluation Based on the Lissaman Wake Model

Step	Activity
1	Determine prevailing wind direction(s).
2	Optimize layout for prevailing direction and stable stratification (see Table 9.1).
3	Create look-up table for cluster efficiency (η_r) as a function of wind speed, wind direction and stability (see Table 9.1) using Lissaman model.
4	Create time series of cluster energy production using time series of wind speed, direction, and by multiplying the cluster's rated output by the appropriate values of η_r.

TABLE 9.1. Recommended Values of Power Law Coefficient and Turbulence Intensity for the Lissaman Wind Turbine Wake Model

Stability Type	Power Law Coefficient $n^{(a)}$	Turbulence Intensity a
"Stable" (nighttime)	0.28	0.01
"Neutral" (early morning early evening, or winter day)	0.18	0.10
"Unstable" (spring, summer or autumn day)	0.13	0.25

(a) See Figure A-2.9.

Table 9.2 outlines a procedure for determining cluster design and predicting cluster performance based on Lissaman's model. The procedure assumes that time-series data on hub height winds are available and that time-series estimates of cluster energy production are desired. Time series of estimated energy production from any machine in the cluster can also be obtained if this is desired.

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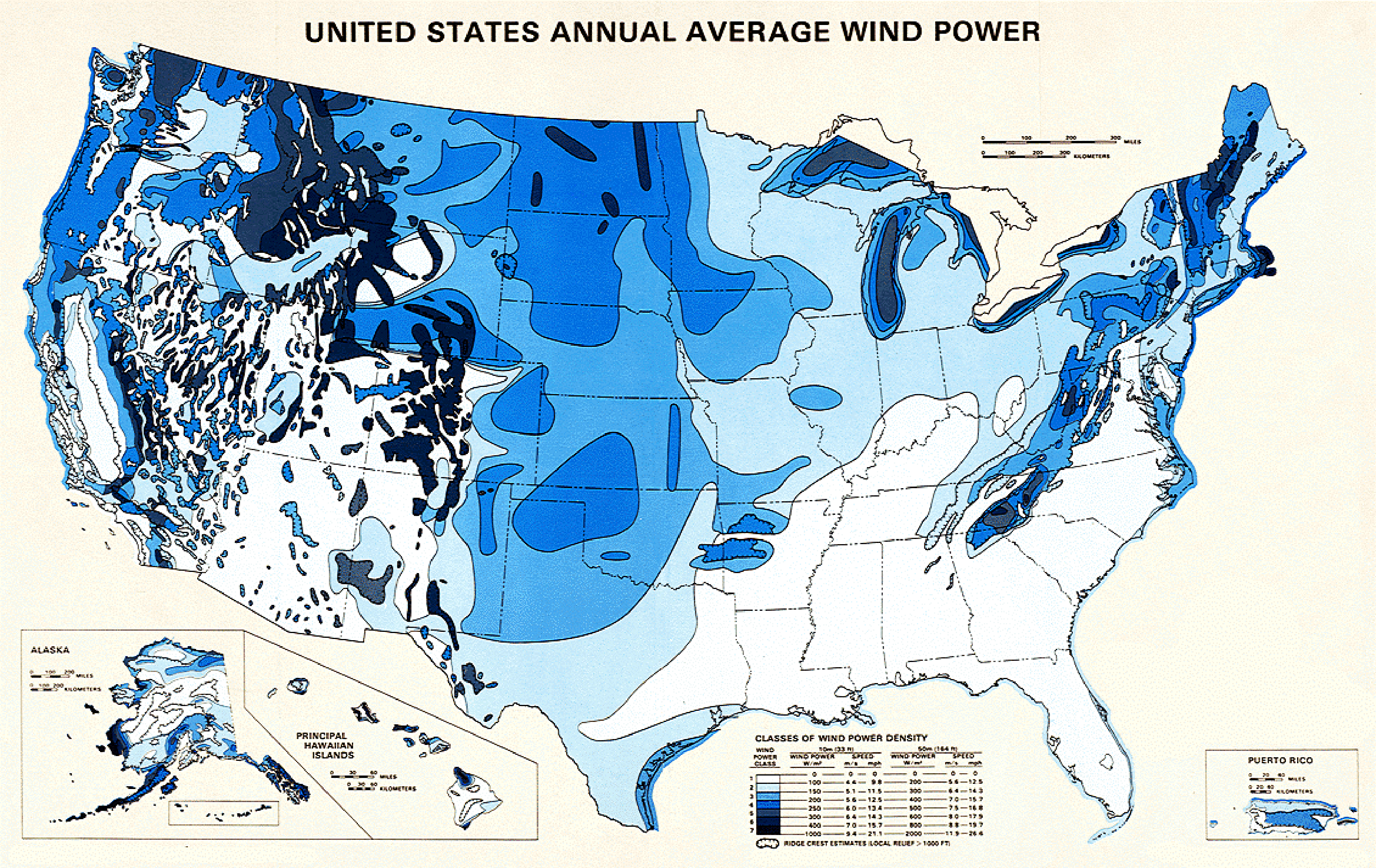

1986 – US wind atlas