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U.S. Hydropower Resource Assessment for Wisconsin

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ABSTRACT

The U.S. Department of Energy is developing an estimate of the undeveloped hydropower potential in the United States. The Hydropower Evaluation Software (HES) is a computer model that was developed by the Idaho National Engineering Laboratory for this purpose. HES measures the undeveloped hydropower resources available in the United States, using uniform criteria for measurement. The software was developed and tested using hydropower information and data provided by the Southwestern Power Administration. It is a menu-driven program that allows the personal computer user to assign environmental attributes to potential hydropower sites, calculate development suitability factors for each site based on the environmental attributes present, and generate reports based on these suitability factors. This report describes the resource assessment results for the State of Wisconsin.

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INTRODUCTION

In June 1989, the U.S. Department of Energy initiated the development of a National Energy Strategy to identify the energy resources available to support the expanding demand for energy in the United States. Public hearings conducted as part of the strategy development process indicated that undeveloped hydropower resources were not well-defined. As a result, the Department of Energy established an interagency Hydropower Resource Assessment Team to ascertain the undeveloped hydropower potential. In connection with these efforts by the Department of Energy, the Idaho National Engineering Laboratory designed the Hydropower Evaluation Software (HES), which has been used to perform a resource assessment of the undeveloped conventional hydropower potential in over 30 states. This report presents the results of the hydropower resource assessment for the State of Wisconsin. Undeveloped pumped storage hydropower potential is not included.

The HES was developed as a tool to measure undeveloped hydropower potential regionally or by state. The software is not intended to provide precise development factors for individual sites, but to provide regional or state totals. Because the software was developed as a generic measurement tool encompassing national issues, regional and state totals must be considered judiciously; various local issues may skew undeveloped hydropower potential totals. The information for the resource assessment was compiled from the Federal Energy Regulatory Commission's Hydroelectric Power Resources Assessment database and several other sources. Refer to DOE/ID-10338, the *User's Manual* (Francfort, Matthews, Rinehart 1991) for the specifics of the software and to DOE/ID-10430.1, the *Status Report* (Conner, Francfort, Rinehart 1996) for an overview of all resource assessment activities to date.

Model Development

Hydropower Evaluation Software, both a probability-factor computer model and a database, is a menu-driven program that is intended to be user-friendly. Computer screens and report-generation capabilities were developed to meet the needs of users nationwide. The software uses environmental attribute data to generate an overall project environmental suitability factor (PESF) between 0.1 and 0.9, where 0.9 indicates the highest likelihood of development and 0.1 indicates the lowest likelihood of development. The suitability factors are dependant on the unique environmental attributes of each potential site. They reflect the considerations that (a) environmental concerns can make a potential site unacceptable, prohibiting its development (for a suitability factor of 0.1), or (b) if there are no environmental concerns, there is no effect on the likelihood of site development (for a suitability factor of 0.9). A combination of attributes can result in a lower suitability factor because multiple environmental considerations would reduce the likelihood that a site may be developed to its physical potential.

Model Goal

The goal of the HES is to assemble an accurate resource database of all sites with undeveloped hydropower potential in the United States for use as a planning tool to determine the viable national hydropower potential. Undeveloped hydropower potential is not limited to the development of new sites; it also includes the development of additional hydropower-generating capacity at sites that currently have hydropower, but are not developed to their full potential. This undeveloped hydropower potential is a source of nonpolluting, renewable energy available to meet the growing power needs of the United States. The HES should help make this goal obtainable and ensure a set of uniform criteria for national assessment.

Dam Status

The effects of environmental attributes vary by dam status. The dam status classifications used are as follows:

W = Developed hydropower site *with* current power generation, but the total hydropower potential has not been fully developed. Only the undeveloped hydropower potential is discussed in this report.

W/O = Developed site *without* current power generation. The site has some type of developed impoundment or diversion structure, but no developed hydropower generating capability.

U = *U*ndeveloped site. The site does not have power generation capability nor a developed impoundment or diversion structure.

ASSESSMENT RESULTS

Summary Results

A total of 102 sites (Table 1) have been identified and assessed for their undeveloped hydropower potential. The HES results for individual site capacities range from 18 kilowatts (kW) to 15 megawatts (MW). All of the HES-modeled sites in Wisconsin are small hydropower sites (no individual site is larger than 20 MW). In fact, 55% of the sites have individual site capacities of less than 1 MW each (Figure 1).

The nonmodeled undeveloped hydropower potential total for Wisconsin was identified as 453 MW. The HES results lower this estimate about 66% to 153 MW. The greatest reduction in undeveloped hydropower potential, by MW, occurs at sites with no structure in place (undeveloped category). These sites have an HES-modeled undeveloped hydropower potential of 26 MW, a 183-MW reduction in the estimated undeveloped hydropower potential (Figure 2). The developed sites, with power, have the lowest percentage decrease in modeled undeveloped potential capacity. The unadjusted potential is 190 MW, and the modeled capacity is 111 MW, a 41% decrease in capacity (Figure 2). As can be deduced from Figure 3, the developed sites without power have the smallest HES-modeled average capacity per site (0.4 MW), and the developed sites with power have the highest HES-modeled average capacity per site (2.4 MW). Figure 4 shows an example of a developed site in Wisconsin.

The 102 identified sites are located within eight major river basins, two lake-based river basins, and several minor river basins. The number of sites per river basin range from 3 in the Lake Superior, Mississippi, Rock, and Wolf-Fox River Basins, to 38 sites in the Wisconsin River Basin (Figure 5). The Chippewa River Basin has the most undeveloped hydropower potential (56 MW) of the Wisconsin river basins (Figure 6).

The State of Wisconsin also provided information on an additional 360 hydropower sites. The undeveloped capacities and stream-flow data are not available for these sites, while the hydraulic head for each site is available. Information on the 360 sites are included in Appendix E, so the reader is aware that these sites have been identified as potentially having some hydropower capacity, based solely on the hydraulic heads. These sites were not included in the HES model.

Detailed Results

The appendices contain, in the form of HES-generated reports, detailed information about the undeveloped hydropower potential in Wisconsin. The appendices contain the following information:

Appendix A — The undeveloped hydropower potential is summarized by dam status groups. The number of sites, nonmodeled undeveloped hydropower potential, and HES-modeled undeveloped hydropower potential is provided based on the dam status.

Table 1. Undeveloped hydropower potential summaries for Wisconsin. The table contains the nonmodeled undeveloped nameplate potential and the HES-modeled undeveloped hydropower potential totals.

	Number of projects	Nameplate potential (MW)	HES-modeled potential (MW)
With Power	46	190.0	111.3
W/O Power	35	53.3	15.7
Undeveloped	21	209.6	26.2
State Total	102	452.9	153.2

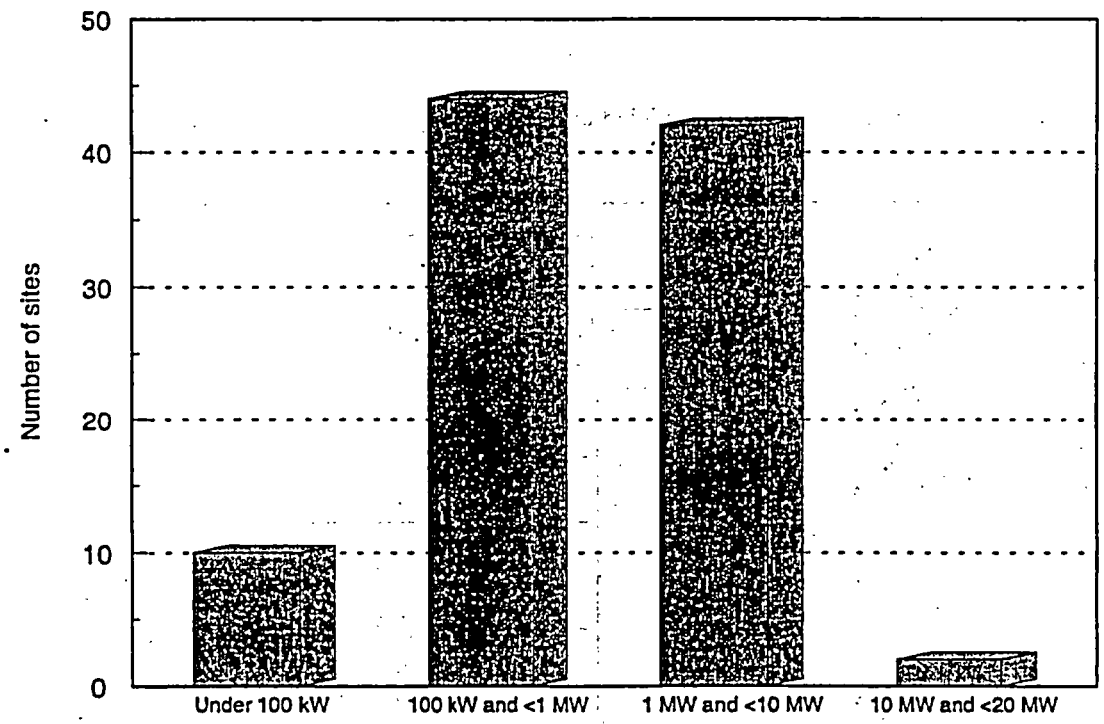

Figure 1. Number of sites, by capacity groups, with HES-modeled undeveloped hydropower potential.

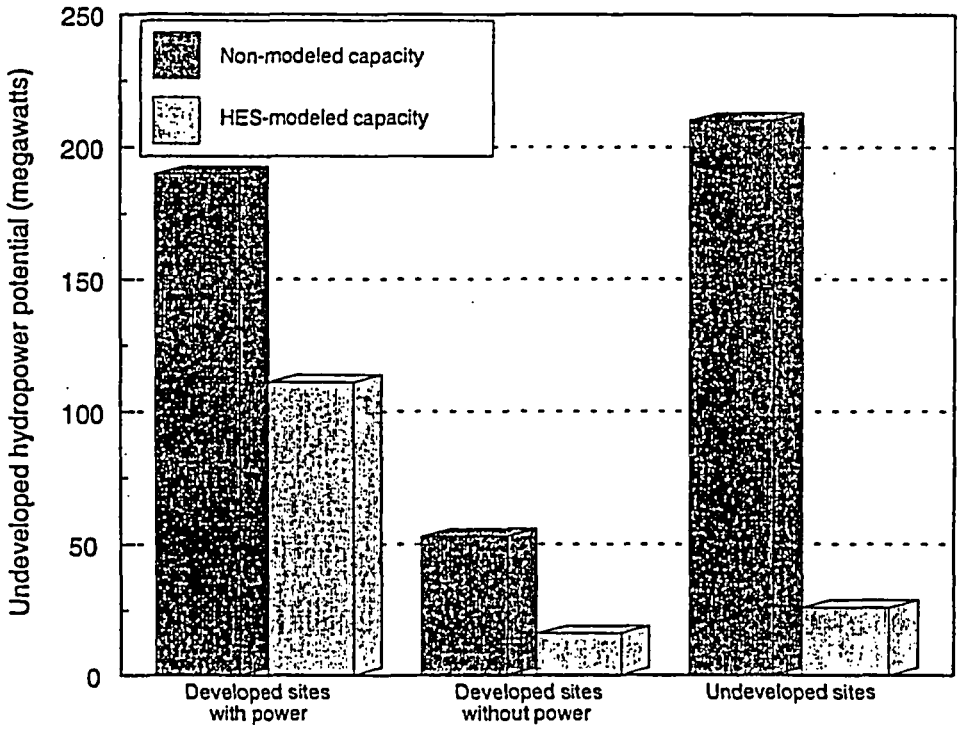

Figure 2. The nonmodeled and HES-modeled undeveloped hydropower potential.

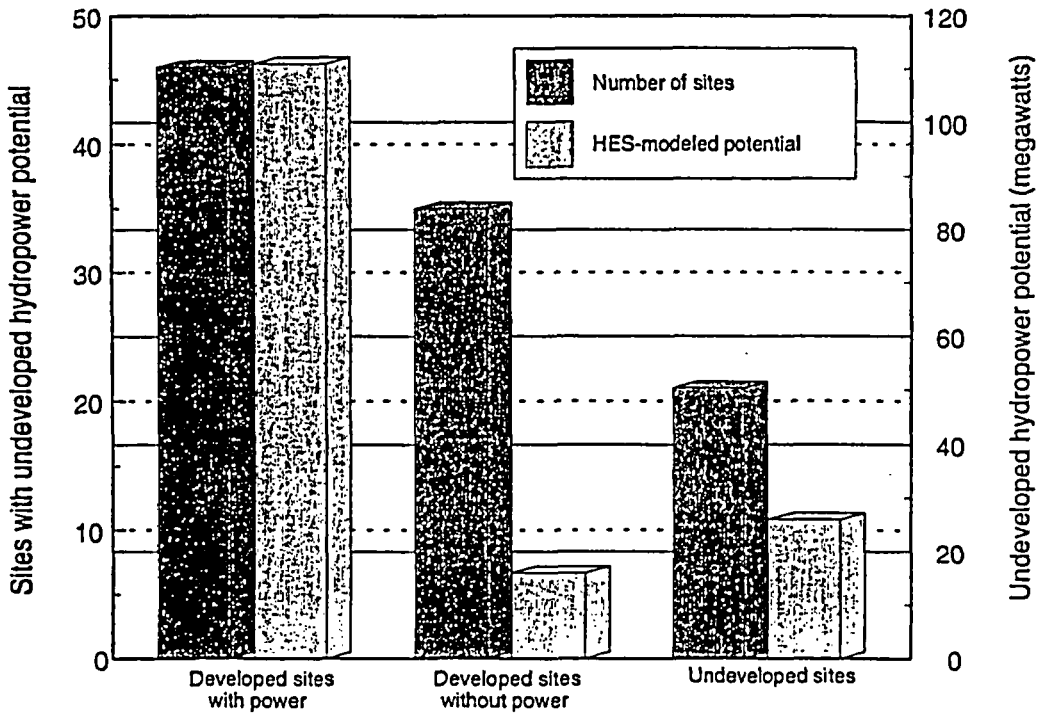

Figure 3. The number of sites with undeveloped hydropower potential and the total megawatts of HES-modeled undeveloped hydropower potential.

Figure 4. The Thornapple Hydropower Project is an example of a developed Wisconsin hydropower plant. It is located on the Flambeau River, in Northwestern Wisconsin, by the town of Ladysmith. The plant has two turbines and 1.4 megawatts of developed capacity.

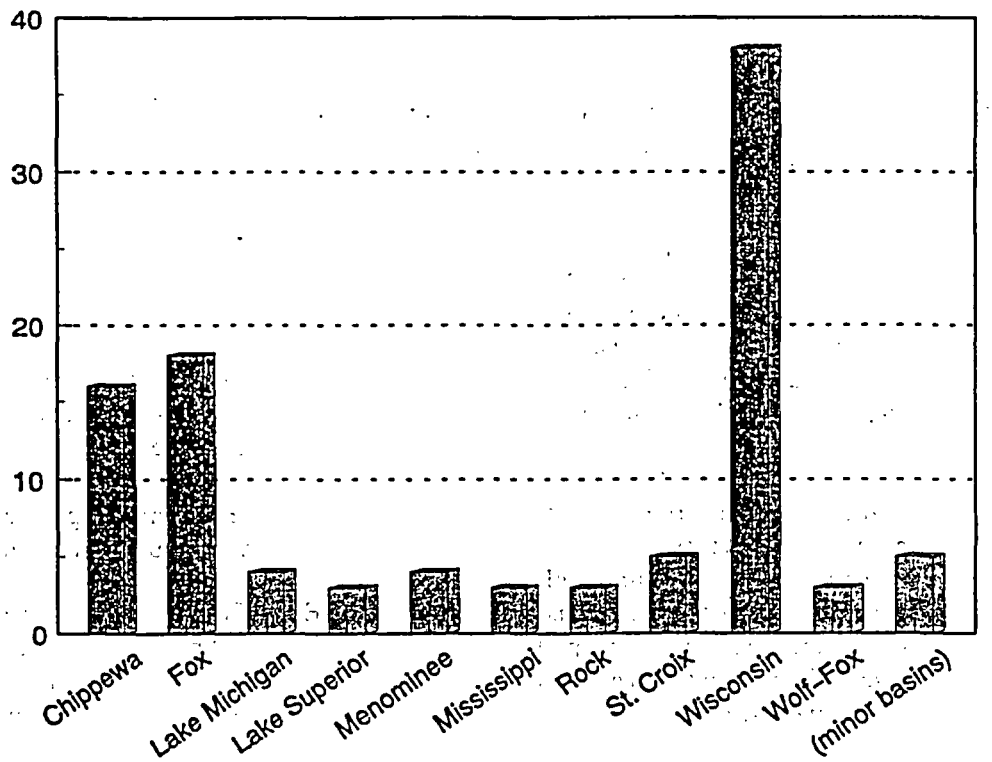

Figure 5. Number of sites with undeveloped hydropower potential in the Wisconsin river basins.

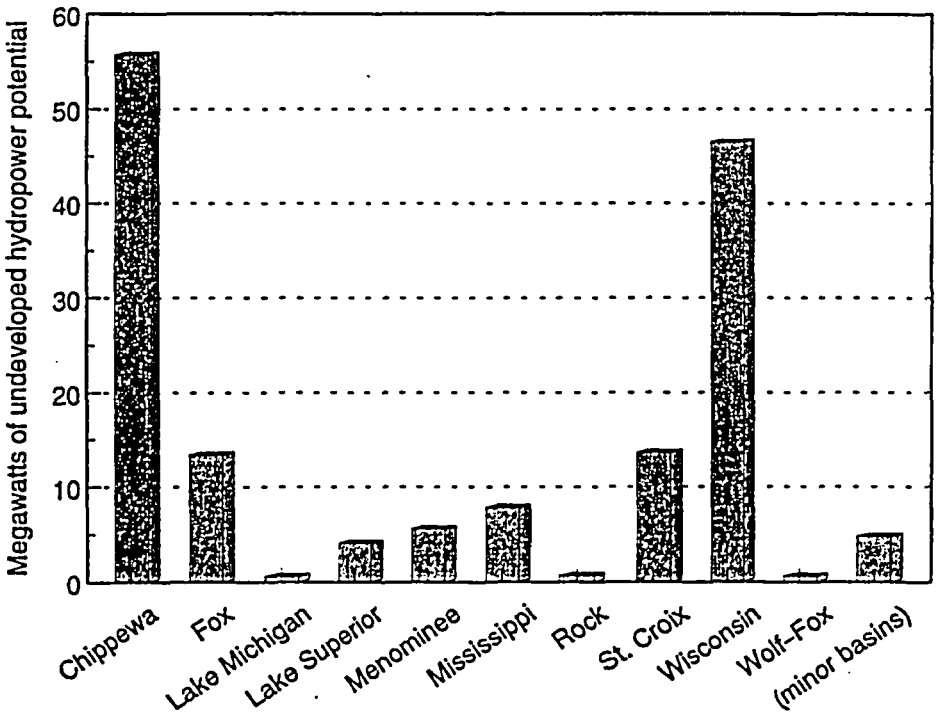

Figure 6. Megawatts of HES-modeled undeveloped hydropower potential in the Wisconsin river basins.

Appendix B — The hydropower resource assessment by river basin includes the project number, project name, stream name, dam status, nonmodeled undeveloped hydropower potential, and the HES-modeled undeveloped hydropower potential for each of the individual sites. Subtotals are provided for each river basin.

Appendix C — This appendix lists the project numbers, plant name, stream name, if a site is Federally owned, nonmodeled undeveloped hydropower potential, and HES-modeled undeveloped hydropower potential. The sites are grouped by dam status.

Appendix D — This appendix contains a resource database list for each of the 102 sites in Wisconsin. Information includes plant name, stream, state, county, river basin and owner names, project number, nameplate and HES-modeled undeveloped hydropower potential, the unit and plant types, dam status, latitude, longitude, and the environmental factors that the HES uses to determine the project environmental suitability factor.

Appendix E — This appendix lists the additional 360 hydropower sites reported by the State of Wisconsin. The list is sorted by dam name.

OBTAINING INDIVIDUAL STATE INFORMATION

Additional copies of the hydropower resource assessment results for individual states are available and can be obtained by writing or calling the authors or the National Technical Information Service (NTIS).

Telephone Orders—(703) 487-4650. NTIS sales desk and customer services are available between 8:30 a.m. and 5:00 p.m., Eastern Standard Time.

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For Help in Tracing an Order—Call (703) 487-4650 and request the customer service option.

ADDITIONAL HYDROPOWER EVALUATION SOFTWARE INFORMATION

Additional information concerning the HES can be obtained by contacting Ben Rinehart or Jim Francfort at the addresses provided below. Copies of the software and the User's Manual may also be obtained from these individuals.

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Information concerning the State of Wisconsin's involvement with the resource assessment or about the identified sites may be obtained by contacting:

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P.O. Box 7921
Madison, WI 53707-7921
(608) 266-3809

REFERENCES

Conner, A. M., J. E. Francfort, and B. N. Rinehart, 1996, *Uniform Criteria for U.S. Hydropower Resource Assessment, Hydropower Evaluation Software Status Report-II*, DOE/ID 10430.1, Idaho National Engineering Laboratory, Idaho Falls, Idaho.

Francfort, J. E., S. D. Matthews, and B. N. Rinehart, 1991, *Hydropower Evaluation Software User's Manual*, DOE/ID-10338, Idaho National Engineering Laboratory, Idaho Falls, Idaho.