REVIEW OF THE WINDPOWER ACTIVITIES AT THE BRACE RESEARCH INSTITUTE

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The Brace Research Institute was set up in 1961 to alleviate the problems of water scarcity in rural areas, with particular reference to improving the productivity in these regions. One of the criteria established from the outset was that as much emphasis as possible be placed on the development of natural energy, local material, and human resources so as to integrate this technology into the indigenous infrastructure. As power is always needed to satisfy man's requirements for new or additional supplies of water, it was decided that windpower should be harnessed as a possible energy source.

Historically, windpower has provided much of man's power needs for pumping, mechanical power, and navigation. The Institute has maintained a basic program of information accumulation, contacting as many of the existing windpower manufacturers as possible. It has invested heavily in library facilities and possesses an excellent series of cross referenced reprints in several languages accumulated over the past 12 years. Since 1963 the Institute has offered courses in wind power technology and utilization. The initial courses were formulated under the direction of the late Professor E. W. Golding of the Electrical Research Association, United Kingdom, under whom this author had the pleasure of studying some 10 years ago.

Initial activities in windpower were undertaken at the Brace Experiment Station in Barbados located in the heart of the Trade Winds. Chronologically, the various phases of windpower work were as follows:

1962-66 Installation and testing of a 1-kilowatt Quirk windmill at Springhead, Barbados - DC current produced (DT.4).

1963-64 Testing of a 9-kilowatt Andreau windmill. In this novel propeller design, air was forced out of the periphery of hollow blades, operating an electric generator in a central tower (T.12).

1964 Development of a simple, do-it-yourself Savonius rotor windmill (L.5).

1965-67 Development of the 10-horsepower Brace Prototype Windturbine. This unit is still in use in an irrigation project in Barbados (MT.7, R.38, CP.19, and CP.20).

Since mid 1967, the principal activities of the Institute have passed to the current headquarters in Montreal, Canada.

The following activities have continued in Barbados, Haiti, Montreal, and elsewhere:

1968-69 The 10-horsepower prototype windturbine was evaluated in Barbados in its role of irrigating land intermittently. This function was performed quite successfully from a technical, agronomic, and soils point of view (MT.8).

1970 Savonius rotors were introduced in Columbia.

1970 A 1.5-meter-diameter Lubing Maschinenfabrik windmill was tested in Haiti. This mill, still in operation, is used to pump saline water to a solar distillation plant.

1971-72 Improvements were undertaken to the design of the Brace 10-kilowatt prototype windturbine.

1971-72 A permanent magnet alternator generator, driven under variable input power to simulate wind regime was tested. Loads were induction motors which performed quite successfully (T.68).

1972 A Lubing Maschinenfabrik 400-watt wind electric generator (blade diameter = 2.2 m) was tested at Montreal. This unit, currently being examined for performance under winter conditions, powers an experimental solar/wind powered house (T.75).

1973 Designs were undertaken of reinforced concrete towers as well as reinforced concrete block towers for windmills (EP.2).

1973 A study has been initiated on developing a mathematical model which can describe the performance of any known wind electric generator whose characteristics are known, given a measured wind regime.

1973 The Brace Windturbine designs were optimized technically and structurally. Final designs were submitted to manufacturers for commercial production.

It can be seen that the programs of the Institute are continuing in an active vein. Future studies are being formulated to set up free wheeling windmills whose power output will be utilized through improved electrical and electronic systems.

In addition, aerodynamicists will examine problems relating to the improved forms of wind energy conversion to mechanical shaft power.

There is a significant potential for windpower utilization in the north of Canada, where the remoteness of the loads favor small, autonomous installations. A reexamination of equipment destined for use in warmer climes is planned so that windmills can perform adequately under these difficult climatic conditions.

The future of windpower both at home, and in the developing countries, seems brighter and more promising than in recent times.

LIST OF BRACE RESEARCH INSTITUTE PUBLICATIONS ON WINDPOWER

Publication No.

R.25 Implications of the Utilization of Wind Power for the Development of Small Caribbean Communities, by R. E. Chilcott, Proceedings of the Conference on Technology and Development in Small Transitional Societies, Trinidad, W. Indies, 12 pp., Feb. 1968.

R.31 Putting the Wind to Work, by the Brace Research Institute, Engineering, Vol. 206, No. 5353, pp. 760-761, Nov. 22, 1968.

R.38 Notes on the Development of the Brace Airscrew Windmill as a Prime Mover, by R. E. Chilcott, The Aeronautical Journal of the Royal Aeronautical Society, Vol. 73, No. 700, pp. 333-334, Apr. 1969.

R.39 The Potential for Medium Power Wind Turbines in Canada and the Caribbean, by R. E. Chilcott and G. T. Ward, Paper No. D.50.853 AGM, presented to the Engineering Institute of Canada Annual General Meeting, Vancouver, British Columbia, Sept. 10, 1969.

R.47 Potential for Medium-Power, Fixed-Pitch, Variable-Speed, Airscrew Wind Machines in Canadian Agriculture, by R. E. Chilcott and G. T. Ward, presented to the Agricultural Institute of Canada - Canadian Society of Agricultural Engineers, Hamilton, Ontario, Jun. 27, 1968.

T.12 Performance Test of an 8-Meter Diameter Andreau Windmill, by A. Bodek, 24 pp., Feb. 1964.

T.36 The Economics of Wind Powered Desalination Systems, by T. A. Lawand, 56 pp., Jun. 1967, revised Sept. 1967.

T.37 Notes on the Development of the Brace Airscrew Windmill as a Prime Mover, by R. E. Chilcott, 7 pp., Sept. 1967 (superseded by R.38).

T.38 Notes sur l'Utilisation de l'Eolienne Rapide Brace comme Source Motrice, par. R. E. Chilcott, traduit par M. Lantagne, 11 pp.,

juillet 1968: French translation of T.37.

T.41 Investigations Concerning Savonius Rotors and Related Turbomachines, by G. Bach, Forschung auf dem Gebiete des Ingenieurwesens, 2, No. 6, pp. 218-231, Jun. 1931, translated from German into English by G. T. Ward, Jun. 1964.

T.42 Practical Experience Gained from the Development of a 100 kw Wind Power Installation, by U. Hutter, Brennstoff-Warmekraft, 16, No. 7, pp. 333-341, Jul. 1964, translated from German into English by G. T. Ward, May 1966.

T.43 Specifications of the Brace 10 hp Airscrew Windmill, 15 Assembly and 70 Detail Drawings, by R. E. Chilcott, H. P. Budgen, O. Goldstein, R. H. Weyts, Feb. 1971.

T.56 Current State of Windpower Research in the Soviet Union, by N. Levy, edited by G. T. Ward, 10 pp., Sept. 1968.

T.68 A Simple Electric Transmission System for a Free Running Windmill, by T. H. Barton, and K. Repole, Aug. 1970, 29 pp.

T.75 A Report on Preliminary Testing of a Lubing Windmill Generator (M022-3G 024-400) of the Brace Research Institute by H. L. Nakra, 5 pp.

L. 5 How to Construct a Cheap Wind Machine for Pumping Water, by A. Bodek, 12 pp., Feb. 1965. Revised Feb. 1973.

I.26 Proposal Submitted to the Freedom from Hunger Campaign, F.A.O., for the Development of a Low Cost Two-Bullock Power Wing-Rotor Wind Machine for Water Pumping in Underdeveloped Arid Areas, by G. T. Ward, 10 pp., Nov. 1963.

I.36 Notes on the Selection of a Suitable Water Pumping System for the Greenland Windmill, by T. A. Lawand, 8 pp., May 1967.

I.40 Report on Visit to St. Kitts-Nevis, Feb. 12-17, 1968, to Initiate a Windmill Water Pumping Project, by R. E. Chilcott, 7 pp., Feb. 1968.

I.45 Proposal for the Establishment of a 10 hp Windmill Water Pumping Pilot Plant in Nevis, West Indies, by R. E. Chilcott and E. B. Lake, 8 pp., Jun. 1968.

I.51 L'Utilisation de l'Energie Eolienne dans la Vallee du Saint-Laurent: Etude des Donnees Meteorologiques Disponibles, par M. Lantagne et G. T. Ward, 7 pp., aout 1968.

I.52 Wind Power Study of the St. Lawrence Lowlands: Survey of Available Wind Data, by M. Lantagne and G. T. Ward, English translation of I.51, 7 pp., Oct. 1968.

I.76 Comments on Brace Research Institute Windmill by A. Wilson, Ministry of Overseas Development, Bridgetown, Barbados, Feb. 1968, 2 pp.

CP.19 Estimation of Maximum Drag and Root Bending Moment on Stationary Brace Airscrew Windmill Blade and Variation of Airscrew Starting Torque with Blade Angle, by P. K. Ghosh, 13 pp., May 1969.

CP.20 Low Drag, Laminar Flow Aerofoil Section for Windmill Blades, by P. K. Ghosh, 8 pp., May 1969.

CP.48 Potential for Wind Power Development in Eastern Canada, by M. S. Kadivar, 8 pp., Jan. 1970.

CP.59 Correlating the Drainage Needs with the Availability of Wind Power in Quebec, by Keith Manuel, 13 pp., 1968.

DT.4 Wind Electric Research Report (Evaluation of the Performance of a Commercial Aerogenerator), by C. Sanchez-Vilar, 30 pp., Aug. 1963.

DT.7 Comparacion de Diferentes Teorias para el Calculo de la Performance de Molinos, by M. A. Nevot, 51 pp., Aug. 1966.

DT.8 Potential of Wind Power Utilization in the Arctic Environment, House Heating, by C. Bettignies, 40 pp., Aug. 1970.

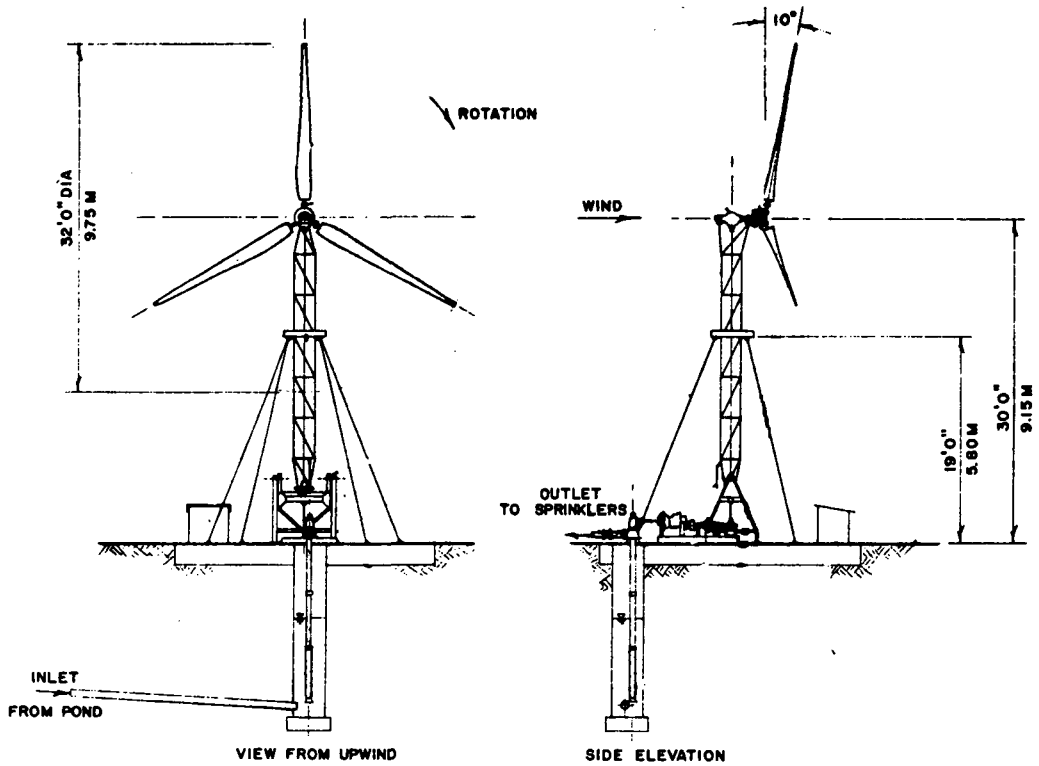
MT.7 The Design Development and Testing of a Low Cost 10 hp Windmill Prime Mover, by R. E. Chilcott, M.Sc. Thesis, Dept. of Agricultural Engineering, McGill University, 126 pp., Jul. 1969.

MT.8 The Field Performance of a Windmill Powered Sprinkler Irrigation System, by J. M. Ionson, M.Sc. Thesis, Dept. of Agricultural Engineering, McGill University, 96 pp., Jul. 1969.

MT.9 Dynamic Analysis of High-Speed Wind-Turbine Systems, by J. S. Duggal, M.Sc. Thesis, Dept. of Agricultural Engineering, McGill University, 74 pp., Jan. 1971.

MT.10 Potential for Wind Power Development, by M. S. Kadivar, M.Sc. Thesis, Dept. of Agricultural Engineering, McGill University, 171 pp., Jul. 1970.

EP.2 Windmill Tower Design, by Frank Montesano and Antonio Fernandez, Project for the Department of Civil Engineering and Applied Mathematics, Course No. 303-318 B, Apr. 18, 1973, 92 pp.



PROTOTYPE BRACE AIRSCREW WINDMILL PUMPING SYSTEM.

Figure 1