Distr.
LIMITED

E/CONF.35/W/22
28 April 1961

ORIGINAL: ENGLISH

UNITED NATIONS
CONFERENCE
ON NEW SOURCES
OF ENERGY

SOLAR ENERGY, WIND POWER AND GEOTHERMAL ENERGY

Agenda item - Point de l'ordre du jour
II.B.3(a) - Recent developments and potential improvements in wind power utilization:
For household and other individual uses

Utilisation de l'énergie éolienne:
progrès récent et améliorations possibles:
Usages domestiques et autres usages individuels

EXPERIENCE WITH JACOBS WIND DRIVEN ELECTRIC GENERATING PLANT, 1931-1957

By Marcellus L. JACOBS
Jacobs Wind Electric Co., Inc., U.S.A.

NOTES

1. The working languages of the Conference are English and French. All papers contributed are reproduced in one or other of these two languages. Where a paper has been reproduced in both working languages for the convenience of a rapporteur, both language versions are provided as part of the Conference documentation.

2. Where any paper has been contributed in one of the official languages of the UN other than English or French, then it has been made available to the conference in that language. A translation of such papers in either English or French (according to the request of the relevant rapporteur) is provided.

3. Summaries of all papers, as presented by the authors, will be available in both working languages—English and French. Summaries will not include diagrams and photographs and should be read in conjunction with the paper proper, which will bear the same reference number as the summary.

4. Papers and summaries will not be generally available for distribution to other than participants and contributors to the Conference until after the Conference, under publication arrangements to be announced.

1. Les langues de travail de la Conférence sont l'anglais et le français. Tous les mémoires présentés sont reproduits dans l'une ou l'autre de ces deux langues. Lorsqu'un mémoire est reproduit dans les deux langues de travail sur la demande d'un rapporteur, la version anglaise et la version française du mémoire font toutes deux parties de la documentation de la Conférence.

2. Lorsqu'un mémoire est présenté dans une langue officielle de l'ONU autre que l'anglais ou le français, il est publié dans cette langue. Les mémoires appartenant à cette catégorie sont en outre publiés en traduction anglaise ou française (selon la demande du rapporteur chargé du sujet considéré).

3. Des résumés de tous les mémoires, établis par les auteurs eux-mêmes, seront publiés dans les deux langues de travail: anglais et français. Les résumés ne contiendront ni diagrammes ni photographies, et il conviendra de les rapprocher du mémoire lui-même, qui portera le même numéro de référence que le résumé.

4. Les mémoires et les résumés ne pourront en général être distribués à des personnes autres que les participants et les auteurs qu'après la Conférence et selon des modalités de publication qui seront annoncées ultérieurement.

EXPERIENCE WITH JACOBS WIND DRIVEN ELECTRIC GENERATING PLANT, 1931-1957

Summary

After several years of testing different types of windmills, a three-blade aeroplane type propeller developed in 1927 was found to be far superior both in power output and in minimizing vibration. A propeller diameter of 15 feet was found to produce ample power, developing 400 to 500 kwh per month in most areas of the western United States with wind speeds ranging from 10 to 20 miles per hour for two to three days per week.

Duel sets of heavy grounding brushes were installed on the armature shaft and a large capacity oil filled condenser connected across the generator brushes and frame to eliminate the otherwise considerable static discharge and damage from lightning, while aluminium painted (copper edged) spruce wood propellers reduced trouble with frost and ice formation.

The total factory cost of the plant of $1,025, or about $400.00 per kilowatt, included $490.00 for a 2500 watt 32 volt plant as well as, optionally, $360.00 for a 21,000 watt storage battery with a ten-year guarantee and $175.00 for a self-supporting steel tower. Operating and maintenance costs of the plant are largely limited to the replacement of the storage battery, while according to records kept for more than 1,000 plants over a ten-year period the repair costs have been less than $5 per year.

Hundreds of these plants, with specially designed generators, are used for the cathodic protection of underground steel pipe lines in several countries.

EXPERIENCE WITH JACOBS WIND DRIVEN ELECTRIC GENERATING PLANT - 1931-1957

MARCELLUS L. JACOBS

JACOBS WIND ELECTRIC COMPANY, INCORPORATED, U.S.A.

A. This report outlines the engineering, construction, performance, electric output, and different uses of the Jacobs Wind Electric 2500 to 3000 watt plant, thousands of which were installed in many parts of the world from 1931 to 1957.

Early engineering started on this wind operated electric generating plant in 1925. After several years of testing different types of wind mills the three blade aeroplane type of propeller was found to be far superior in power output. By means of a flyball governor operated variable pitch speed control, the maximum speed of the propeller was accurately and easily controlled, to prevent excessive speeds in high winds and storms. The three blad propeller was found to be necessary (as compared to the two blade type) to prevent excessive vibration whenever the shift of the wind direction required the plant to change its facing direction on the tower. The periods of vibration which occurred, on the two blade propeller, every time the tail vane shifted, to follow the changes in wind direction, were found to be caused by the fact that the two blade propeller, when in a verticle position, offers no centrifugal force resistance to the horizontal movement of the tail vane in following changes in wind direction. However, when the two blade propeller is in the horizontal position its maximum centrifugal force is applied to resist horizontal movement of the tail vane, thus the tail vane is forced to follow wind direction changes by a series of jerks, causing considerable serious vibration to the plant. The three-bladed propeller was developed by us in 1927 to correct this condition. When in operation the three-blade propeller creates a steady centrifugal force resistance, against which the tail vane reacts with a constant pressure and produces a smooth shifting horizontal movement of the plant facing direction The centrifugal force generated by the very light Areoplane spruce wood blades, when operating at 225 R.P.M. is 550 pounds each, making a force of over 1600 pounds of gyroscopic resistance force to the horizontal vane movement, for the three blades but this resistance is in the form of an even pressure or resistance to horizontal movement. Whereas the 1100 pounds of gyroscopic resistance force, of the two blade propeller, to the vane movement is applied and then eleminated twice during each revolution.

B. A propeller diameter of 15 feet was found to produce ample power for electric generator operation to develop 400 to 500 K.W.H. per month, based on the available winds in most areas of the States in the Western half of the United States. This required 10 to 20 mile per hour winds for two or three days per week. A specially designed 6 pole battery charging type shunt generator was developed to operate at a speed range from 125 to 225 R.P.M. for direct connexion to the governor hue of the propeller. It was designed so that its load factor would exactly parallel the power output curve of the wind driven propeller when operating in the 7 to 20 M.P.H. range that it was

felt produced to most hours of wind per month. Wind plants that require higher than 20 M.P.H. winds to deliver their rated output will find too many areas where there are too many days with winds below that speed each month and thus their effective average monthly output in many areas is below expectations. The generator weighs 440 pounds with a 9 inch diameter armature with a 9 inch core length. The 60 pounds of wire on the field poles gave maximum efficiency with a drain of less than 100 watts for field coil operation. The generator output is 2500 watts at 32 volts and for the 110 volt generator it is rated at 3000 watts.

C. Our experience with plants installed in many parts of Alaska, Canada, Finland, Northwestern United States and a number of special installations such as the plant we have installed for the joint operated U.S. and England weather station at Eureka (in the Arctic Circle) and with the Byrd expedition at Little America, has shown that aluminum painted (copper edged) spruce wood propellers have considerably less trouble with frost and ice formation than when they are varnished or other type coatings used.

D. Generators located on high steel towers are subject to considerable static discharge from the armature thru the ball or roller bearings and excessive charges from nearby lightning will often arc thru a bearing and weld spots on the balls and race, causing it to brake up soon. We found the revolving propellers collected discharges into the direct connected armature and the lightning pickup effect of the propellers was frequent and of considerable intensity. To correct this we installed dual sets of heavy grounding brushes on the armature shaft which completely eliminated any trouble from this cause. With the additional use of a large capacity oil filled condenser connected across the generator brushes and frame we practically eliminated any damage to the generators from lightning. So much so, that with high grade ample insulation used throughout the generator and the grounding brushes and condensers we gave an unconditional five year guarantee with every generator against burn-out from any cause and have built many thousands during the past 20 years using this construction without any replacements ever being required because of lightning damage or burn-out from any cause.

E. The price received at the factory for our 2500 watt 32 volt plant was $490 less the cost of a suitable tower and batteries, which could often be secured in the country or area to which the plant was shipped. We supplied a 21,000 watt hour glass cell lead-acid type of storage battery with a ten-year guarantee, we received $365 for it. A fifty-foot self-supporting steel tower was supplied for $175, making a total cost for the plant of $1,025. This is about $400 per Kilo Watt as the manufacturing cost of the plant. Shipping and installation costs are additional. Installation cost requires only the labour of two men for two days and a small amount of cement to put into the anchor holes when the tower is built. No special equipment or training is necessary. We have shipped hundreds of plants to most countries with not a single request for additional information to enable them to erect the plant. Regular installation and operating instructions are prepared and sent with each plant.

F. Operating and maintenance costs of this plant are largely limited to the replacement of the storage battery, which on a ten-year basis is about $36 per year and from records kept of more than 1,000 plants over a ten-year period the maintenance cost of repairs was less than $5 per year. Some of the owners of our plants bought the Edison Type battery and after 20 years are still using the same battery. New batteries of this type are quite expensive but these owners bought second hand batteries and they still gave them 20 years service.

G. Special generators designed for the cathodic protection of underground steel pipe lines were developed by us in 1936. These generators were wound for an external circuit resistance of 1/10 ohm or higher. The generators produced 10 volts at 100 amperes and were straight shunt wound. When connected to the pipe lines in any normal wind they maintained a pipe to soil potential of 3/10 of a volt pipe negative. Due to the action of the current the pipe maintained a fair degree of protection thru calm wind periods. Hundreds of our plants are protecting many miles of pipe lines in North America, South America and Arabia. These plants have been in service since 1937 and later.

Litho in U.N.

W 22
50546-May 1961-800