Technical Notes on Renewable Energy Systems to be Used at the Indian Station

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ABSTRACT

Renewable energy systems utilising the wind and solar energy have shown promising results in Antarctica. This paper describes the various renewable energy systems that are proposed to supplement the existing conventional sources of energy.

INTRODUCTION

Two forms of energy find ready use at the Indian camp at Dakshin Gangotri, electricity and heat. Both electricity and heat are presently generated with the help of diesel sets. Diesel sets are by nature reliable and quick starting type of generating equipment. They, however, have some inherent disadvantages, namely, that of maintenance and large requirement of fuel. The transportation and storage of fuel on the frozen continent is both troublesome and provides a fire hazard. It would therefore be prudent that alternative energy sources be installed at the camps in Dakshin Gangotri and Maitree Hills. Winds and solar energy are the two abundant sources of energy, which if harnesed, can perhaps cater to the total energy needs of the entire Indian stations in Antarctica. These renewable energy systems have no fuel requirement and are almost maintenance free.

WIND MILLS

The weather data recorded at the Indian station and at Novolazharevskaya, strongly indicates the presence of strong katabatic winds throughout the year. An average speed of 10-15 m/s, going upto 65 m/s have been recorded at the Indian station.

The wind data have been analysed and a frequency distribution curve has been drawn (Fig. 1). The study shows that for the maximum utilisation of wind turbine, the cut-in, design and cut-out wind speeds should be 20 kmph, 40 kmph and 60 kmph respectively.

Also, the wind is available throughout the year and the direction is mostly from SE (±22.5). Thus to make the design simple, reliable and strong enough to withstand the high winds, it would be desirable to have a wind mill without turntable and tail for automatic changing direction to face the wind. A manual systems for the same may, however, be provided. Wind turbines of about 2.5 kW capacity are being presently used in India. Average wind speeds of about 18 kmph are available in India. The annual average wind speeds recorded at the Indian station is about 35 kmph. With cubic law of power with velocity, 8 times power from the same machine can be generated (Fig. 2). However, for higher wind speeds, the rotor would rotate at higher speeds giving problems of material strength.

Thus, for the first unit as a test prototype, the size should be limited to 2.5 kW capacity. This machine shall require a diameter of about 2 metres and a tower height around 7 metres. The generator should be a DC generator with constant output voltage irrespective of rpm and should be utilised for battary charging and room heating. These machines can also be used effectively for water pumping applications at the Maitree station.

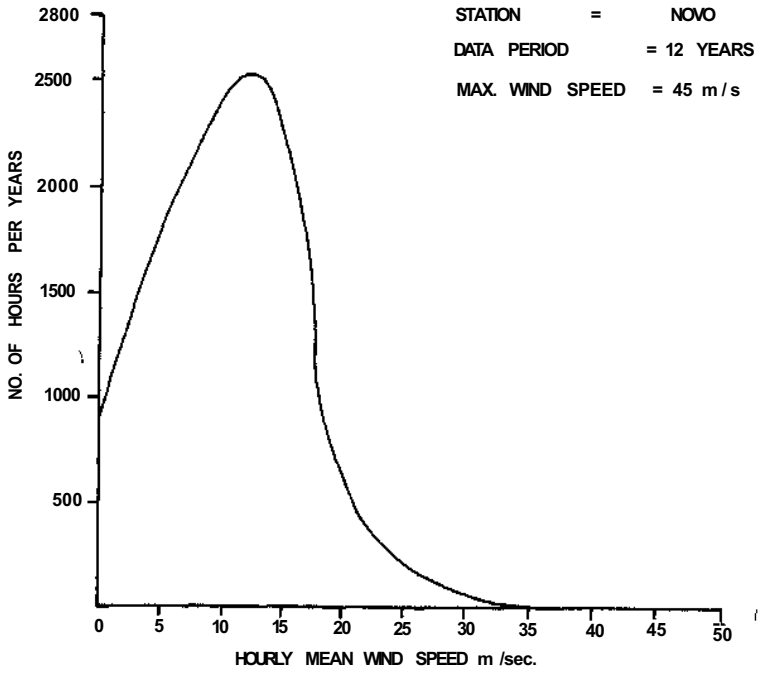

Fig. 1. **Annual frequency distribution of wind speed at the USSR station-Novolazarevskaya. The data are based on observations for 13 years.**

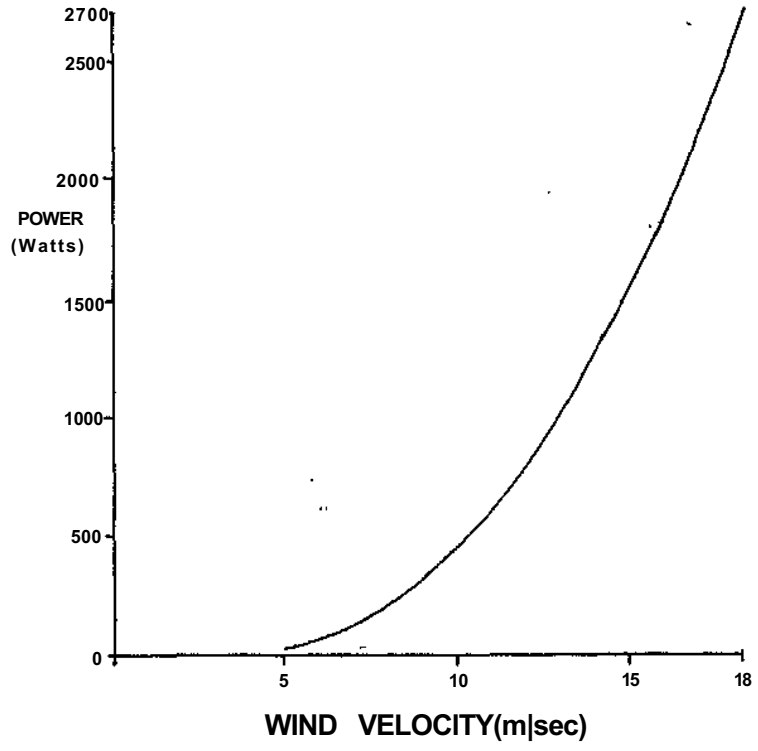

Fig. 2. **Expected power output from the wind electric generator.**

SOLAR HEATING SYSTEMS
(Plate 1)

Ambient temperature remains in the range of -12°C to +4°C, during the period December to February. Peak insolation levels are of the order of 400-500 W/m^2. Solar energy available during the Antarctic summer (December to February) is about 62% of the annual solar energy available. Wherein the sunlight is avilable for more than 18 hours a day. Although snow blizzards are quite intense during the non-sunny periods, they are fairly less frequent in the summer months.

As both the Indian stations are likely to remain fully inhabited by large parties during the summer months, it may be worthwhile to explore the possibility of using solar heating systems in Antarctica. The main objectives of such an exercise could be:

(a) to work out the feasibility,

(b) to supplement the conventional sources of energy,

(c) to study the suitability of various materials and

(d) to gain experience in design, fabrication, assembly etc.

SOLAR THERMAL SYSTEMS

These systems can be deployed as a hot water source for persons, kitchen and room heating etc. These should work on Thermosyphon principle in a closed loop, thereby eliminating the use of pumps. Thus to start with, these systems should be of a low capacity, say 100 litres per day. As the working fluid can not be water due to freezing problem, an antifreeze can be mixed in suitable proportion. The total system consists of a solar collector, support structure for the collector, insulated storage tank, insulated pipe lines and necessary instrumentation to monitor the operation of the system.

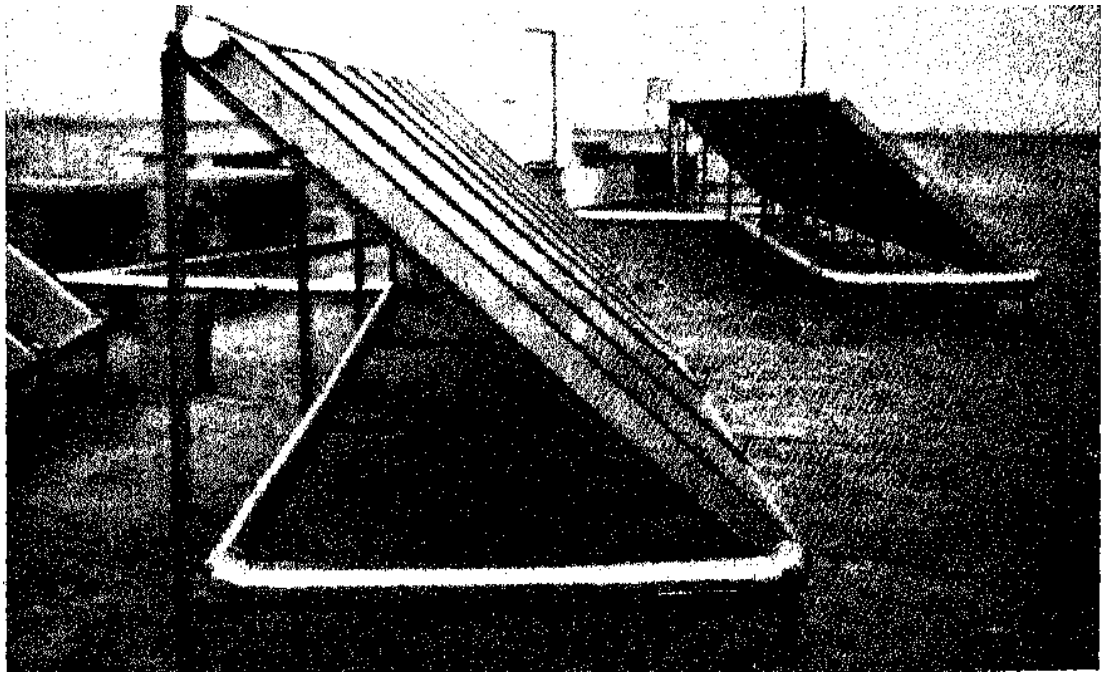

Plate 1. **Photograph showing the solar panels used by the fourth expedition for producing solar heating on a trial basis.**

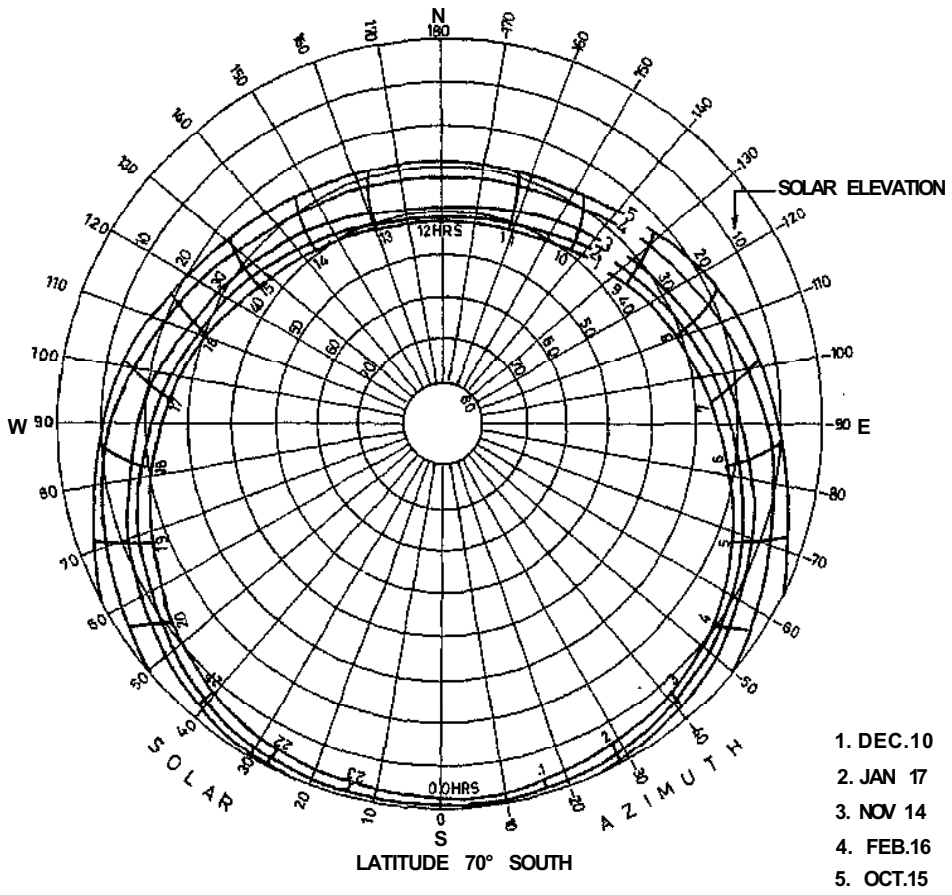

Fig. 3. Sunpath diagram for latitude 70°S (Antarctica).

Solar collector array has to be designed keeping the sun movement in mind. A set of collectors facing East, North and West shall have the most optimum orientation, wherein most of the direct sunlight can be intercepted to give maximum output (Fig. 3).

PHOTOVOLTIC SOLAR SYSTEMS

Photovoltic modules presently available in the country can work satisfactorily at very low temperatures (-40°C) and can be used in conjunction with the storage batteries for room lighting system and inland communications. The lead-acid batteries are not found suitable for low temperature applications. These can be used if housed inside the rooms where ambient temperature is maintained at around 18°C. Any snow collected on the solar panels has to be continuously removed.

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