Internet Enabled
SOLAR PV DESIGN AID EXPERT SYSTEM

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ABSTRACT

This paper presents an Internet enabled expert system for the design of solar photovoltaic power supplies. The objective of the expert system is to have a software tool on the computer that shall provide comprehensive support to general users for the design of solar photovoltaic electricity generating units. The product is envisioned to provide general users the power of an expert, in the matters of design considerations. It will also be adaptable easily to a change of design conditions.

INTRODUCTION

The expert system is a software tool on the computer that is envisioned to provide general user the power of an expert. At IIT Delhi we have developed a solar PV design aid expert system and have subsequently modified it at Bharati Vidyapeeth College of Engineering at New Delhi. The project was sponsored by Department of Science and Technology Government of India and Programme Advisory Committee (PAC) of Electrical, Electronics and Computer Engineering of Department of Science and Technology reviewed the product on 31st August 2001 at IIT Chennai. The committee felt that a solar PV design aid expert system could be useful to the cross-sections of researchers /professionals other than those working in the field of solar photovoltaics; for example communication engineers and professionals designing solar powered communication units and systems. We have, therefore, widened the availability of this expert system by making it accessible to communication media available to masses. These days Internet has received steadily increasing attention among masses. There are only few topics hotter than the Internet. Technically speaking, Internet is actually a Global Network (World Area Network) made up of many smaller local networks (Local Area Network) that exist all over the world. The LANs are connected with WAN through an Internet host computer commonly called Server, which in turn is connected with individual personal computers. Presently Internet is the largest computer network in the world and is growing very fast. In January 1977 an estimate on Internet was 4.8 millions host which became 16.1 millions host within two years. There are many different ways to get access to the Internet and in this way the Internet has become the information superhighway for technological communication and utilization.

DESIGN AID EXPERT SYSTEM

In conventional power plant the engineering design is based on installed capacity whereas a solar PV system is highly modular in nature; so system capacity is not a consideration in their design. The engineering design of solar PV system is based on site parameters (i.e. climatological data), system configuration and load parameters. The system performance exclusively depends upon these parameters. Therefore, it would be desirable to size each PV system individually for each set of site and load. Furthermore, the solar PV system can be operated in several modes such as stand-alone with and without storage battery, hybrid and grid connected in accordance with their several applications. However, the design methods of stand-alone systems only have reached a stage of maturity we, therefore, consider stand-alone solar PV system for the development of design-aid expert system.

The intended objective of the expert system is to develop a software tool on the computer that shall

provide comprehensive support to general users for the design of solar photovoltaic power supplies. The product is envisioned to provide general users the power of an expert in the matter of design considerations (Waterman, 1986). An expert system for Indian region has been developed (Kaushika, 2002) based on substantial field experience and design knowledge about component of solar PV system. The schematic is shown in Figure 1. The knowledge base is the heart of the system. It involves combining both site and array characteristics in a single parameter referred to as Equivalent Unit Array Output (EUAO) and expressing the composite parameter as a function of geological co-ordinates (Kaushika, 2001). The knowledge base is evolved from the climatological data of 14 stations in Indian region. It enables the determination of the size of PV array and battery bank, which can deliver power to load without failure. The input and output parameters for system with and without battery storage are illustrated as follows:

1. **Solar PV system without battery storage**

Input parameters

Geographical parameters: Latitude (degree), Longitude (degree)

Load parameters : Daily mean load (kWh/day), load operating voltage (volt

Array parameters: Peak power rating of the each module (W_p)

Effective voltage of each module (volt) = Maximum power point voltage (Vmax)- voltage correction due to temperature (8-10% of Vmax)- voltage drop across blocking diode (1-1.5 volt)- charging allowance (1-2 volt)

Output Parameters

Array Optimum tilt angle: the optimum tilt angle will be that angle for which the total annual value of Unit Array Output is maximum. In field condition it is the tilt angle from the horizontal at which the array is being installed. It is expressed in degree.

Array capacity (in Wp)

Number of modules in series

Number of such series string in parallel

2. **Solar PV system with battery storage**

Input parameters

Geographical parameters : Latitude (degree), Longitude (degree)

Load parameters : Daily mean load (kWh/day), load operating voltage (volt

Array parameters : Peak power rating of the each module (Wp)

Effective voltage of each module (volt) : as illustrated in case of solar PV system without battery storage

Autonomy days : Number of consecutive days the solar PV array is not supplying power to load.

Output Parameters

Array Optimum tilt angle (in degree).

Array capacity (in Wp)

Battery capacity

Number of modules in series

Number of such series string in parallel

WEB SITE DEVELOPMENT AND ACCESS

The website corresponding to the expert system has been prepared and was first placed on Internet for 15 days and subsequently the website was placed on Internet and outline of the uploading procedure is as follows:

a. We make self-extracting zipped file. The self-extracting zipped file does not require win zip software for extracting the zipped file. The file can be downloaded from any where on any machine. The necessity of zip in general arises when there are more than one file required to run the knowledge-base (e.g. the executive / compiled file of knowledge base program and the executive file of turbo C compiler). The zipping saves space as well as download time.

b. The executive files of knowledge base and Turbo C are zipped in a single file named setup.exe with the help of win zip software. Afterwards we make this setup.exe file self-extracting.

c. Then this setup.exe file is placed on the web server for downloading (Fig. 2)

The addresses of the websites are

Intranet http:// 10.116.2.103/ndkaushika/
Internet http:// nd-kaushika.tripod.com

The website contains following sections which are linked to their description as follows:

(i) Home: This is the instruction of the system

(ii) Design approach: This section describes the design approach and knowledge base of the system

(iii) Design aid expert system: This section describes the input and output parameters of the system. An input output display is given in Figure 3

(iv) Download: This section describes the download, install and run procedure of the system.

(v) Contact person: This section provides contact address, email & Telephone number of Project Incharge for further queries.

CONCLUSTION

This paper outlines a simple and workable internet enabled design aid expert system for solar photovoltaic power supplies. It ensures the power of an expert in the supplies. It ensures the power fo an expert in the hands of general users.

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