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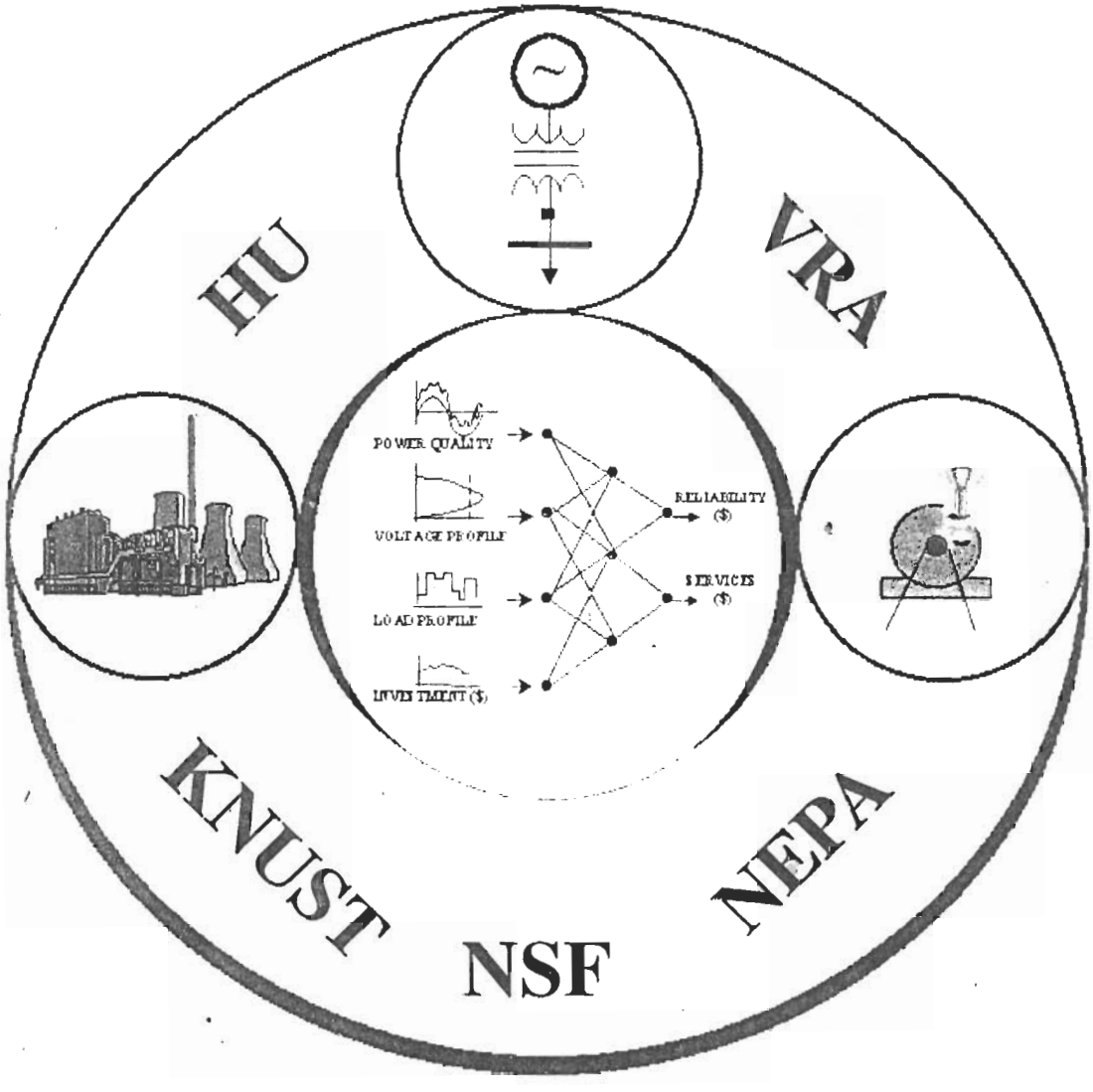

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POTENTIALS OF PHOTOVOLTAIC SYSTEMS FOR RELIABLE POWER SUPPLY IN NIGERIA

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ABSTRACT

The available generating capacity within the national grid network is not enough to meet the electrical demand for industrial, commercial and domestic uses. There is the need to include solar photovoltaic power systems in the energy mix of the country at least, to take care of small loads in some rural communities where grid electricity has not been extended. This paper examines generating capacity and the problem of outages in the national grid network and the potentials of solar-photovoltaics in several sectors of the Nigerian economy.

Keywords: Generation, outages, photovoltaics, potentials electricity, rural.

INTRODUCTION

The various electricity generating stations of the National Electric Power Authority (N.E.P.A.) have a total installed capacity of 5296MW distributed among the generating stations as shown in Table 1.

Table 1 Electricity Generation Capacity of NEPA.

Power station	No. of Generating units	Energy Type	Turbine set	Installed Capacity (MW)
Kainji	8	Hydro	Hydraulic	760
Jebba	6	"	Hydraulic	540
Shiroro	4	"	Hydraulic	600
Afam	17	Gas	Gas	665
Egbin	6	Fuel, oil & Gas	Gas and steam	1320
Ijora	3	Gas	Gas	60
Sapele	10	Gas and steam	Gas and steam	976
Delta	14	Gas	Gas	312
Oji River	1	Coal	Steam	30
Others	46	Diesel	Diesel	33
			TOTAL	5296

Currently, NEPA's power stations produce about 99.5 percent of the total electricity generated for public consumption in the country. The balance of 0.5% is purchased by the Authority from private companies. With a National peak demand of 2500MW the country theoretically has a reserve power ratio of more than 50%. However, there is a wide gap between installed generating capacity and the effective power generating capacity. For example, a recent report indicated that due to low water level, the total generating capacity from the three hydro stations dropped from 1900MW to 1239MW. With the Afam and Ijora stations currently shut down and the other thermal stations operating below capacity, the country's combined electricity generation has dropped as low as 1,183MW, the lowest in 28 years of NEPA's history (1). The reasons adduced for this scenario include lack of regular maintenance, obsolete equipment, lack of spare parts, inadequate supply of fossil fuel and vandalisation of equipment. The limitations in the transmission system are due partly to the inadequate capacity of the combined 132/33KV and 132/11KV stepdown transformers and the remoteness of most of the stations from the load centres. This affects the reliability of the transmission system, thereby causing frequent transmission outages and occasional system collapse. The provision of electricity to consumers is therefore not steady and reliable. By virtue of the large landmass of the country, the over 50,000 kilometres of cable lines in the distribution system have not reached most of the rural areas. This creates the need for the consideration of the solar-photovoltaic power system option which has modular characteristics favourable to decentralised power supply.

2: INFRASTRUCTURE AVAILABILITY IN NIGERIA

Figure 1 shows the percentage of households by type of electricity supply under two categories namely, no electricity (NE), National Electric Power Authority (NEPA) in the urban, Semi-urban and rural areas of the country (2). Above 80% of the households in the rural areas do not have access to electricity. This impairs the provision of infrastructures for lighting, water pumping, communications, vaccine refrigeration and other applications necessary for enhancing The standard of living of rural dwellers. Poor lighting from kerosene and oil palm lanterns is partly responsible for the high incidence of fire outbreaks and eye diseases.

Each of the 36 states in the federation has water a Board established to supply clean water within the state. However, the services of the boards are extended mainly to the urban and semi-urban areas. Water supply in the rural areas is mainly from wells and streams which do not meet basic sanitary standards. A recent report by the World Bank shows that 74% of the rural population in Nigeria do not have access to safe drinking water (3).

In the agricultural sector, only 0.7% of the 330,000 square kilometres of available cropland area is irrigated. The low level of irrigation farming has a link with the lack of electricity supply to most rural farmers who account for more than 90% of the food production in the

Country can be achieved if each university is supplied with a 50KW, PV system. Thus, for all the universities, 20MW p of PV power will be required.

3.3. Telecommunications Sector

Significant progress in the adoption of PV has been made in the telecommunications industry. In 1992, a policy decision was made by NITEL to use PV power systems for repeater stations. So far, about 60 repeater stations have been adapted to the PV power supply option. NITEL is also committed to the development and adoption of cellular communications systems (6). The recently promulgated national telecommunications policy has amongst its objectives the installation of 5 million new subscriber telephone lines within the next five years. The planned privatisation of NITEL, coupled with the issuing of licences to PTO's and ISP's is bound to create an atmosphere of competition in the telecommunications market. Operators who invest in efficient and reliable PV power systems are likely to enjoy good patronage from subscribers.

3.4. Health Sector

The Agubia Health Centre refrigeration system installed in Enugu State in 1990 is a typical example of PV-power refrigeration systems in the country. Under the AZD programmes, twenty (20) 0.5KWp units were installed in hospitals and clinics in Borno, Yobe and Katsina states. The three tiers of Government (Federal, State, Local) are committed to the provision of primary health care through a network of community health clinics. A conservative deployment of twenty (20) 0.5KWp PV systems in each of the 747 Local Government Councils will account for a total PV module power of 7.5MWp.

3.5 Oil/gas Sector

A major problem facing the Nigerian National Petroleum Coporation is the uncertainty about the conditions of the underground bulk transmission pipelines. A recent report on the study of the facilities had recommended that urgent strategies be taken to begin a remediation of the cathodic protection system. It is estimated that $1 billion would be required for the replacement of the over 3000 kilometre pipelines and terminals. PV-powered cathodic protection systems would be ideal for reducing or eliminating the pipeline corrosion in the oil and gas sectors. Also of interest in the oil and gas sector is the use of PV systems to power remote telecommunications, measurements and data acquisition systems.

3.6 Transport and Aviation Sectors

The railway network serves only 20% of the cities in country. Government's interest in industrialisation and revival of the agricultural sector has led to a policy to expand the rail network. For effectiveness in the system, investment in reliable power systems for the signalling equipment along the rail routes is inevitable. A role for PV along the rail routes in the hinterlands will improve the reliability of the signalling facilities and the efficiency of the Railway Corporation.

The paved road networks in the country connect the big cities and traverse the entire country. Along the inter city routes, tollgates have been erected for revenue collection from all categories of vehicles. The high incidence of road accidents prompted the recent calls on the government by the Road Safety Commission to establish health clinics along the highways. Reliable PV-powered systems for the toll-gate communications equipment and the road-side clinics (for lighting and refrigeration) is essential to improve road transportation in the country. In the aviation sector, a more reliable service will be achieved if PV systems are incorporated to supply power for lighting and communications facilities in the 19 airports in the country.

4. ECONOMICS OF PV SYSTEMS

Photovoltaic power systems have been proven to be reliable and cost-effective for low-power requirements for lighting, water pumping, communications, vaccine refrigeration, etc. Straight economic comparison of the cost of water from PV pumps and diesel pumps showed that PV was more cost-effective up to hydraulic energies of 1000m^4/day (7).

On a life-cycle-cost basis, PV systems were compared with diesel generator and hybrid (PV/diesel generator combination) systems (8). For loads under 6KWh/day and 120KWh/day PV was found to be cheaper than the hybrid and diesel generator options respectively (Figure 2). Between approximately 6 and 250 KWh/day the hybrid option has the lowest life cycle cost of energy. The capital to operating cost comparison of the three options is shown in Figure 3. The capital cost of a 100% PV system is much higher than that of a 100% diesel generator system but its operating cost is much lower. The results obtained (9) from the life cycle cost analysis of a repeater station in Nigeria (Figure 4) shows that while the operating cost of the PV system is minimal, the hybrid system is more cost effective.

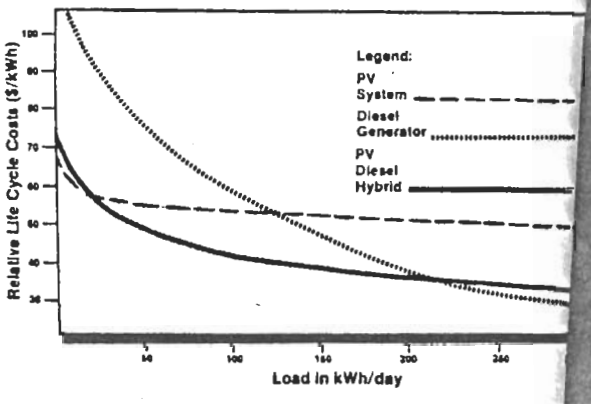

Fig. 2: Life Cycle Cost Comparison