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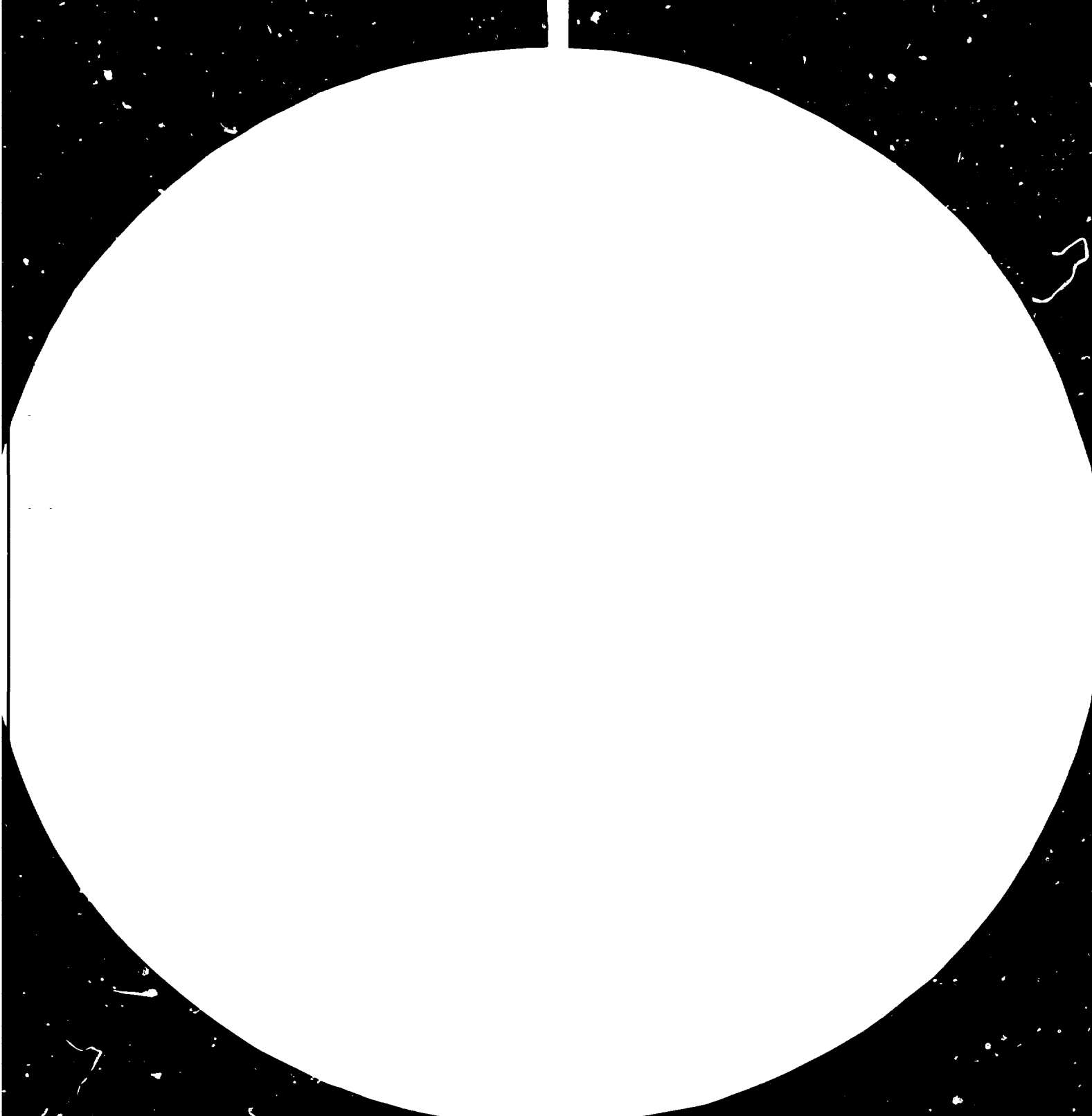
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MINIMUM RESOLUTION TEST CHART

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MICRO-HYDRO GENERATION IN PAPUA NEW GUINEA*

by

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General Facts

Papua New Guinea has a land area of 178,260 square miles lying between the equator and 12 degree to latitude. The central part of Papua New Guinea has one of the great mountain systems of the world, with peaks up to 15,000 feet elevation. Many rivers originating in the mountains and fed by rainfall, averaging about 80 inches per year (with some having rainfall as high as 200 inches) makes for a very large hydro-power potential estimated by some to exceed 30,000 MW.

Some areas, along major rivers as they move across more level lands towards the sea are classified as permanent swamp lands. The climate is distinctly tropical all year with about the only changes during the year coming in the amount of rainfall marked by a monsoon season from December through April. Dense jungle forests are characteristic of a large part of Papua New Guinea where almost every kind of tropical plant flourishes with heavy rain forests growing in profusion below 3,000 feet elevation.

Typical day time temperatures in the coastal areas run to run 90°F with cooler temperatures in the higher elevation and is sometimes quite cool in the highland mountains at night. Papua New Guinea does not normally experience hurricanes but is subjected to rather frequent earthquakes.

Recent scientific methods indicate the highlands of Papua New Guinea may have been inhabited as early as 8,000 B.C. to 50,000 B.C. The early populations were basically hunters, but later emigrations introduced agriculture with such plants as yams, taro, sugarcane, green vegetables, bananas, other fruits and pigs. Along the coast the sago palm and coconut were bountiful as well as sea foods. The introduction of the sweet potato from South America increased food production significantly and encouraged population growth, especially since it grows well in the cool highlands where yams do not.

Under a United Nations approved mandate the Government of Australia administered the affairs of Papua New Guinea under a trusteeship up until September, 16th 1975 when full Independence was gained. The total population of Papua New Guinea is presently estimated at four (4) million people having as 750 to 800 languages.

A co-operative movement introduced in 1948 for the operation of co-operatives in a developing country is now officially recognised as important in providing a service to the people who would otherwise be unable to participate in economic development and for educating people in effective business methods. The co-operative movement is under the control of the Department of Business Development and services some 400 plus co-operatives of all types including retail and marketing co-operatives as well as wholesale organisations and others involved in shipping, finance and insurance.

Papua New Guinea Electricity Commission

The Papua New Guinea Electricity Commission was formally gagatted as a Statutory Authority under an Act of Parliament in November, 1963. From its inception in 1963, the Electricity Commission has followed a growth pattern which has reflected the growth pattern of the country it has served. Under the Electricity Commission Act, principlly it operates to realise its two basic functions:-

- "(a) to plan and co-ordinate the supply of electricity through-out Papua New Guinea; and
- (b) to generate, transmit, distribute, reticualte and sell electricity."

The Papua New Guinea Electricity Commission is headed by a Commissioner and is assisted by four (4) Assistant General Managers whose areas cover Commerical, Personnel Management, Engineering Development and Engineering Operations. Under the two Engineering Departments are four (4) Engineering Divisions (headed by Chief Engineers) covering System Planning, Design and Contracts, Generation and Distribution and Transaission. An establishment chart is a dipicted as per Appendix.

The Electricity Commission has over the recent years engaged outside consultants to study Rural Electrification with particular application to Papua New Guinea (of which their reports have been well documented) which in the main has provided a basis for the Commissions Planning Division to envisage a ten (10) year forecast. Based on the ten year forecast (reviewed annually) the Commission's Design and Contracts Division performs feasibility studies in areas of both fixed and varying load growths with a final recommendation to the Government of Papua New Guinea. Copies of such reports are further submitted to intending financiers for their elvaluation of which the Asian Development Bank has been the foremost in this regard. The Commission further, provides for the training of Management and Operations personnel who come under the control of the Hydro Generation Engineer under the Generation Division. The Papua New Guinea Electricity Commission conducts its on training programme to cater for its specific needs of which it presently has some 300-400 apprentices in training. The Electricity Commission is also a large employer of both 'white' and 'blue' colour employees and presently employs some 2,500-3000 officers and employees.

AIMS OF PAPUA NEW GUINEA

The aims of Papua New Guinea can be summarised as follows:-

1. A rapid increase in the proportion of the economy under the control of Papua New Guinean individuals and for groups and in the proportion of personal and property income that goes to Papua New Guineans.
2. More equal distribution of economic benefits, including movement toward equalisation of incomes among people and towards equalisation of services among different areas of the country.
3. Decentralisation of economic activity, planning and government spending with emphasis on agricultural development, village industry, better internal trade and more spending channelled to local and area bodies.
4. An emphasis on small-scale artisans, service and business activity relying where possible on typically Papua New Guinean forms of business activity.
5. A more self-reliant economy less dependent for its needs on imported goods and services and better able to meet the needs of its people through local production.
6. An increasing capacity for meeting government spending needs from locally raised revenue.
7. A rapid increase in the equal and active participation of women in all forms of economic and social activity.
8. Government control and involvement in those sectors of the economy where control is necessary to achieve the required kind of development.

THE WORK FORCE

PNG now regulates the entry of people from other countries seeking employment in the country. This plan ensures employment opportunities for local citizens - and now more and more of the skilled and semi-skilled positions are being filled by New Guineans.

Special training measures and ordinances are being adopted to assist persons accepting new responsibilities.

An ample supply of labor is available in the unskilled and minimum skilled areas of employment.

ENERGY SUPPLY SITUATION

Papua New Guinea has in the main enjoyed a favourable investment climate and the Electricity Commission has catered for electricity demand growth rates within the range 11% to 21%. The growth has naturally occurred around the main urban areas and has been due, for the most part, to domestic and small scale industrial development electricity requirements. With the exception of Port Moresby (on the Southern side of the country) and Lae, Madang, Goroka, Mt. Hagen, Kundiawa and Kainantu, it has not been economical to supply the main urban areas from suitably sized hydro-electric schemes. Thus, the Commission presently owns and operates nineteen (19) diesel supply facilities and two hydro supply facilities. In addition, the Commission, on behalf of the Papua New Guinea Government, provides staff, training and engineering expertise for the operation and maintenance of electricity supply facilities in over 150 minor rural centres. There are a number of industries which generate their own electricity. Two of the largest of such industries are noted:-

- (a) Bougainville Copper Pty. Ltd., has a steam power station at Arawa Bay and has an installed capacity of 135 MW.
- (b) Commonwealth New Guinea Timbers Pty Ltd. has two hydro electric power stations at Baiune having a total installed capacity of the two power stations of 6MW.

The above organisations, by order of the Commission, have a franchise to supply electricity to the public.

Over the years, there has been various development on both the Rouna and Ramu Hydro Electric Complexes. Although Papua New Guinea's Hydro-Electric potential has long been recognised, there are a number of factors which have ~~initiated~~ ^{militated} against the development of this potential.

AGRICULTURAL PRODUCTION

Major agricultural product for export features cocoa, copra, palm oil, tea, coffee, rubber and forestry products. Less important for export are peanuts and tobacco.

Beans, maize, citrus fruit, paw paw, tomatoes, lettuce, strawberries, taros, yams, bananas, coconuts, rice and some white potatoes are produced mainly for domestic consumption. Thousands of acres are planted with sweet potatoes.

There are about 30,000 cattles in Papua New Guinea. Of that number about 10,000 were dairy cattle.

Pigs are very important in the local economy, perhaps mostly as a symbol of individual or village wealth.

Poultry raising is a significant part of village life, but they are usually running wild and are not well fed. A small number of commercial units are appearing to supply the needs of nearby city residents.

Some donkeys, goats and horses are also kept, but not in sufficient numbers to have economic importance.

SEA FOOD AND FISHING

Fishing is concentrated on tuna, lobsters, prawns, and a fish called barrumundi. Some 24 P.N.G. prawn trawlers are licensed about 1/3 that number are under outside ownership and operate in P.N.G. waters. The industry is handicapped by the lack of facilities to refrigerate and process sea food for transportation to markets.

PNG also has one trout farm which supplies fresh trout to in-country restaurants.

MINERAL PRODUCTION

A major copper mine went into production on Bougainville in 1972 representing an investment of approximately \$400 million (Australian). Estimated reserves run to 700 million tons of copper ore, along with significant amounts of gold and lesser metals.

The PNG government holds 20% of the capital stock in the Bougainville mine and in addition, collects royalties and taxes, so that total revenue to the government from this mine, covers about 30% of the central government's annual budget.

Another copper ore deposit on the mainland estimated by some to be larger than the Bougainville deposit has been taken over under a government corporation, O.K. Tedi, Ltd., for development.

In 1973, there were 135 prospecting titles (permits) in PNG covering some different minerals, with the greatest interest being in copper.

FOREST PRODUCTS

PNG has hundreds of thousands of acres of valuable timber land with exploitation rights held by major producers, most of whom are Japanese and Australian.

Production for export includes logs, sawed timber, wood chips, veneers and plywood, and pulp.

The Forestry Research Division indicates that several varieties of trees suitable for utility poles are in good supply, but there is little activity in this field thus far.

SECONDARY INDUSTRIES (MANUFACTURING AND PROCESSING)

The main secondary industries producing for export would probably are:

- Copra crushing mills
- Plywood production
- Palm oil processing
- Desicated coconut factory
- Extraction of pyrethrum
- Tea factories
- Coffee roasting and packing

Production for local markets and minor exports include:

- Aerated water
- Biscuits
- baskets
- Batteries
- Beer

Glass bottles and containers
Steel drums and metal buckets
Canvas goods
Chemicals (agricultural - industrial - domestic)
Cigarettes
Concrete blocks and components
Clothing
Fiber board containers and packing metals
Paper towels and toilet rolls
Ice cream
Metal decking and roofing
Galvanizing iron sheets
Fencing materials
Fiber glass
Marine products
Bottled gas
Louvre windows
Paint
Joinery, timber and pre-fab building
Radio assembly
Refrigerators
Sheet metal works and water tanks
Meat small goods
Stationery and printing
Cookingstoves
Plastic bags and containers and other products.

HANDICRAFT PRODUCTS

Wood carvings
Weaving silk and wool
Blankets
Floor rugs
Ponchos and other products

TRANSPORTATION

Over 100,000 motor vehicles of all types were registered in PNG. Our 4 of these are company owned vehicles and the rest are privately owned.

While there are actually some 10,000 miles of roads in PNG, only a few roads have sealed surfaces and most are subject to frequent washouts, landslides, and other problems. The two principal towns on the mainland, Port Moresby and Lae, about 150 miles apart, have no connecting road.

The new highlands from Lae to Laiagam, a highway distance of almost 450 miles through mountainous terrain is major communications link even though the road does not yet have a sealed surface.

Most areas of PNG are almost totally dependent on air travel and are served by many small planes and local grass airstrips which often are not useable after heavy rains. Many thousands of people in PNG would still need to walk for days to get to the nearest airstrip or road.

EDUCATION

The school system of Papua New Guinea includes government schools and schools operated by churches and Missions. Only 35% of the school age population were receiving any schooling.

So far, a relatively small percent of local young people attend secondary schools.

The University of Papua New Guinea enrolled its first students in 1966 and by the end of 1979, had an enrollment of some 10,000 students.

The University of of Technology offered its first courses in 1967, and had 550 students by 1973. The enrollment in 1979 is near the 5,000 mark.

There are more agency (church and mission) teacher training facilities than government institutions for teacher training.

The educational system also includes vocational schools and in this category, the majority are government operated.

There are also schools of Agriculture and Forestry.

Some of the factors are stated:

- (a) Whilst there have been high growth rates at the Main Towns, base loads in these Towns have been relatively small. Many of Papua New Guinea's potential hydro-electric schemes call for initial stage developments of hundreds of MWs. Unit sizes of increasing capacity at Electricity Commission diesel power stations have ranged between 600kw to 3,300 kw.
- (b) Small unit increases in capacity have allowed firm capacities to be in relative close proximity to installed capacities. This would not have been possible with large scale hydro electric development.
- (c) The capital intensive nature of hydro-electric development compared with similar sized diesel development.

The ultimate objective is to achieve the least possible reliance on imported fuels for the generation of electricity. This objective will naturally be realised mainly by the development of hydro generation plants. In view of the aforementioned, where-ever possible, all diesel generation be if public or private will be replaced with Hydro generation where-ever this replacement can be proved to be possible and economically viable.

Most micro hydro generation at this point in time will be as run of the river' schemes. However as evident in the principle of run of the river' schemes, the Commission has provided supplementary thermal plant to provide the necessary electricity during draughts or periods of low rainfall. Supplementary generation plant also provides reliability in the event of hydro plant or transmission line loss.

Load growth in Papua New Guinea is proceeding at such a strong steady rate that financing of more than one major hydro station at any one time to meet the demand will severely stress the Commission's financial resources. It is extremely difficult for a developing country to find the finance for large capital generation plants to meet the rapid load growth that Papua New Guinea is experiencing. The World Bank and the Asian Development Bank's generosity in the past, in this regard, has been appreciated.

