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5
Power plants

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POWER PLANTS
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1. INTRODUCTION

Plans are being made to replace the small electricity generators, serving individual villages in Suriname's interior, with bigger units, each servicing a cluster of villages. Let me state it bluntly: that would be a disaster for the development of the villages. In this essay I explain why.

2. THE VILLAGES

Scattered over the interior of Suriname, there are some two hundred small villages, whose electrification is the subject of this publication. Many planners predict that these villages will disappear within a generation. If that is a good prediction, investment in public services is futile. So every plan for public services should start from a demographic analysis. There is no authoritative analysis available. In a separate publication (Buanda Achtergrondartikel #5: Planning of settlements) we present our analysis. In synopsis: we predict that roughly half the villages will survive in their present size, and that some of them will germinate new separate villages, and that no mid-size village will emerge. This prediction stands under the assumption that the government will allow the villages to develop themselves in peace, and does not ruin economic opportunities. The latter is quite possible, for example by introducing mid-size power plants - but now we anticipate the conclusion of this paper. To start the analysis, we assume that there are some two hundred small villages and that it is worthwhile to invest in their infrastructure.

3. ALTERNATIVES

There are many ways to generate electricity. Some can be rejected offhand for Suriname's interior villages - alternatives like thermonuclear power plants and windmills. Others are equally unrealistic, but they need to be mentioned because they always pop up when energy is discussed. We will do so in the next paragraph. The reader who is not a novice in the subject of small scale energy generation should skip these paragraphs. First in paragraph 7 realistic alternatives are discussed.

4. SOLAR ENERGY

To be more precise: this paragraph is about photo-voltaic cells that charge double-lead-acid batteries for storage. There is a highly vocal lobby that claims that solar energy is competitive with burning diesel fuels. This sounds attractive, but when we study the figures, we must conclude that we are still an order of magnitude from this ideal.

4.1. NOT CHEAPER

Solar energy is already competitive in some exotic niches: spacecraft, meteorologic stations, telecommunication. In telecommunication solar energy has earned a position in Suriname's interior villages. But for village electrification, these villages are not exotic enough to make solar energy compatible - except, possibly, one or two extremely small and isolated Amerindian villages. This holds even when one grossly overestimates the lifetime of the components, ignores the damage done by falling tree branches, slingshots and theft, ignores the costs to step up 12 Volts direct current to 127 Volts alternating current, and compares theoretical costs for solar panels with time proven operating costs for diesel generators - and even if the help of all these accountancy tricks, solar energy is still way out of the picture. As prices drop, solar energy will gain a foothold in more and more niches, but it is not te be expected that solar energy will become competitive in interior village electrification within the lifetime of the next generation generators.

No one can see in the future, true - but a substantial enough reduction of cost price needs a couple of years for the industry to adapt to a breakthrough in technology, and such a breakthrough (amorphous panels was the last candidate) has not yet been made.

4.2. NOT CLEANER

Then there is this environment argument. This is a highly valid argument, and it is even more valid in concentrated generators than in small generators spread over a large interior. Remember the slogan "the solution to pollution is dilution", and if the Suriname government is seriously considering to replace diesel generators with solar panels for environment's sake, it should start with the large generator in Paramaribo. We know, that is a ridiculous proposal. But we have not yet met an advocate for solar energy who could explain why it should not be ridiculous in interior villages.

Remember too, that diesel fuel is not an entirely unnatural product - carbohydrates are a intermediate product of bio-degration of biological organisms - and in small enough concentrations, they are fully biodegradable. Unfortunately, this does not hold for the lead from discarded solar panel batteries. Lead is one of those heavy metals that are prone to enter the food chain, and we are talking about considerable amounts of lead when discussing solar energy on some scale. This argument is usually overlooked, presumably because often large scale photovoltaic electricity is coupled to grit electricity, and in that case storage batteries are not used. Of course, lead from discarded batteries can easily be recycled. But since not even the most vocal advocates for solar energy have not seriously worked on a recycling program for the lead that is being dumped around solar energy installations for two decades, we must conclude that no one really cares about environmental issues when solar energy is propagated.

Please don't kill the bearer of the bad news. The authors of this paper are quite concerned about environmental issues, but we can't help that the situation is as it is.

4.3. NO OPTION

Our conclusion is: solar energy is no real option for Suriname interior village electrification. This is not exclusively our conclusion. Many vast reports on this issue have been issued, and we refer to the literature (including the report of de Castro, much cited by the solar energy lobby) for who needs further convincing.

5. POWER LINE TO BROKOPONDO

This alternative keeps on being anticipated by the population in Saamaka, because it was suggested in the nineteen sixties as a trade off: "just hand over sixteen hundred square kilometres of tribal area, and we will use it for a hydro-electric lake and then we all get free electricity for ever - you too." The politicians used this kind of simplified picture, and the engineers must have kept mum - anything goes of you need to destroy a score of villages without opposition - although the engineers must have known that the cost of 150 km high voltage line through a jungle area and some fifty step-down transformers would be ridiculous - not just the investment, but especially the maintenance costs: one can not have a tree falling into a 161KV conductor. In the nineteen sixties one did not yet consider environmental damage, but nowadays one should realize that this maintenance means permanent deforestation of at least fifteen square kilometres.

Short and good: a power line to Afobaka is no option for electrification of the villages in the upper Suriname river basin area.

6. MICRO HYDRO-ELECTRIC POWER PLANT

With a micro hydro-electric power plant we refer to a Kaplan turbine in a natural waterfall, generating a hundred kilowatts or more. In the Saamaka scale of things, we should not call this a micro-solution, but hydro-electric power plants tend to be huge: hence the name.

6.1. TAPAWATAA

In Saamaka, there is only one location considered remotely feasible: Tapawataa. Careful calculus reveals that even there it is not really competitive with diesel generators, but if the government is prepared to pay for the ecologically more sound solution, for the diversification of know-how that it would generate and the extra administration that any partial solution would require, it is worthwhile.

6.2. GAANDAN

Since we happen to know the local situation better than most planners, we venture to suggest studying an alternative location: Gaandan. Tapawataa has just upstream of the proposed site for the turbine a shallow sand pit, the water at the entrance of a turbine tends to be quite turbulent, and even a low concentration sand-slurry is a good abrasive for turbine blades. Gaandan has no such disadvantage. Moreover, Gaandan has more fall height in a more concentrated gutter, and maybe this would trade off the costs and nuisance of the five kilometre power line the Gaandan location needs. Maybe - we did not do the study to find out which alternative is better, we only suggest that such a study might be worthwhile.

7. DIESEL GENERATORS

Agreed, they are noisy, filthy, maintenance sensitive contraptions and the transport of the fuel is a headache. But still, diesel generators are the only feasible option for interior village electrification, and will remain to be that for many years. Within this option, there are three alternatives: small scale, medium scale, and large scale generators. In this paper we will study the relative merits of these for the upper Suriname river basin area, called Saamaka. In this area, there are 56 villages. The small scale option uses 42 generators of 5kW to 60kW, each servicing one or two neighbouring villages. The medium scale solution uses 11 generators of some 200kW, each servicing a cluster of one to fifteen villages. The large scale option uses one huge generator for the entire area. We will first study the technical considerations.

7.1. FUEL EFFICIENCY

Larger units, generally spoken, make higher fuel efficiencies possible. This is no physical law, but a technical-economical one: in larger units it pays to invest in refinement. A highly sophisticated fuel pump that works on load and speed to improve performance a few percent only worth the investment if a few percent means a lot of money. A computer driven fuel injection and valve timer may squeeze a little more power out of a barrel fuel, but costs as much as many barrels - and so on. Such improvements are not gradual; they go in steps: above a threshold the refinement pays off, and below the threshold it does not.

Between the small scale and medium scale generators, there is no such threshold. For more output power in the 5kW to 200kW range, the diesel motor factory simply adds more cylinders in line. Only for the larger generators, the more efficient turbines come into the picture, but it needs some careful calculus to find out if the large scale option falls above this threshold: Saamaka is a small community, and what we call "large scale" from the Saamaka perspective, is still small for a powerhouse engineer.

7.2. CAPITAL INVESTMENT - DYNAMO

Scale does not affect efficiency for dynamos in the range we are discussing here. Even in the small scale option, the efficiency is so high that further improvement is not worth the trouble.

7.3. CAPITAL INVESTMENT - ENGINE

Though the fuel efficiency of small scale and medium scale engines is equal, the small scale engine is relatively more expensive than the medium scale engine. A medium scale diesel plant may be just a series of small cylinders in line, but these cylinders share some peripherals - fuel tank, flywheel, casing - and that reduces cost.

But over the life time of a generator, this is hardly worth mentioning. A two thousand Euro generator is likely to consume some fifty thousand Euro worth in fuel during its economical lifetime, so here we are talking about mere trifles.

8. ELECTRICAL GRIT

Quite another matter is the electrical grit - that contraption of hardwood poles, ceramic insulators and aluminium cables to transport the electricity from the power plant to the customers homes. That this grit is more expensive than the generator, both in capital investment and in maintenance, is often overlooked.

Within the villages, all three options of diesel generators and the hydroelectric plant need the same grit. The medium scale and large scale options need power lines between villages too. Worse, they need high voltage lines and step-down transformers, and the longer the line, the higher the voltage must be. For the two to five kilometre power lines in the medium scale option, a kilovolt or two may suffice, but for the ninety kilometres power line in the large scale option, one should visualize a hundred kilovolts. The author of this paper is an engineer and could calculate the optimum voltage and the cost of all step-down transformers, but this exercise is futile: costs explode with distance, and this makes the large scale option not worth further consideration. We are not talking about just the capital investment, but about maintenance too. With 127 Volts, one can simply nail an insulated wire to a tree and forget about maintenance till a fuse blows - I know that NEN1010 regulations forbid this, but it is done everywhere and people get away with it - most of the times, anyway. Instead, just imagine a kilovolt power line between villages, a rain-heavy tree leaning into the conducting wire, and a flock of barefooted schoolchildren passing by on the waterlogged soil of the trail running along the power line ...

High voltage lines need maintenance - maintenance in advance, that is, which is more expensive than the happy-go-lucky repair-when-broken maintenance, and careful inspection that this maintenance is indeed performed before accidents do happen. The cost of such maintenance makes that we can ignore the large scale option without detailed calculation - we don't even want to consider the scenario above with a 100kV power line.

When comparing the two remaining options - small scale and medium scale - one should compare the difference in capital investment between 42 small generators and 11 mid-size generators with the initial investment of some 15 km power line and some 31 step down transformers. We might quarrel over these numbers because various plans vary in detail, but the entire exercise is futile. Since this a comparison between two roughly equal large numbers, this calls for careful calculus: rules of thumb won't suffice. Any consultant engineer can perform such calculus (it is quite straightforward) but the outcome depends heavily on input parameters like the relative cost of labour versus locally produced fuel versus imported machinery, and the willingness of the government to issue free fuel, and all that for the next twenty years. Such parameters are unpredictable, so we should call it a dead heat: within the error marge, caused by conjunctural uncertainly, there is no technical-economical preference for small scale generators over medium scale generators, or reverse. The decision therefore should be made on other arguments.

9. ENVIRONMENTAL DAMAGE

Quite a considerable fraction of the diesel fuel transported to Saamaka is reported to seep out of busted containers. This is of environmental concern. Luckily, very little of this enters the eco-system - most of the lost diesel fuel miraculously finds its way to the fuel tanks of DAF trucks. There is no indication of carbo-hydrogen pollution in the river. Roughly half the discarded carter oil is thrown away on the spot and the soil around the powerhouses is so filthy that termites move out. For this reason, the local population does not object such pollution. luckily, the idea to use this highly carcinogen residue to fight termites in living spaces has not yet proliferated. Instead, it is used to lubricate chain saws, but there is not yet any medical evidence for increased cancer risk.

Environmental concern should not wane and one should warn against its hazards, but there is no environmental reason to discourage diesel generators - yet. If it ever comes that far, one should remember the rule "the solution to pollution is dilution", and this means that medium size power plants will become source for concern earlier than small scale power plants.

10. DEMOGRAPHY

In the opening paragraph of this study, we postulated that most of the small villages in Suriname's interior are there to stay, given no active government campaign to relocate the population. It is therefore not necessary to anticipate a spontaneous migration to some medium size semi-urban centre, and start concentrating the power plants there. In effect, such a move would be counterproductive, and we will explain why.

When population densities shift and generators become obsolete before their economical lifetimes end, or instead too small for an increased demand for electricity, it is relatively easy to replace them. Heavy they are, but loading them in a dugout canoe is almost routine for Saamaka lumberman. But a powerline is something else: it is not a movable item, and it ages slowly: it should be designed for ages.
It sounds so logical: small villages are anachronisms, let us anticipate population clustering in mid-size centre and prepare for that by installing mid-size generators - but this reasoning is much flawed.

First, the small villages are no anachronisms. Our publication "Buanda Achtergrondartikel #5: Planning of settlements" explains why. Second, urbanization is an all-or-nothing process, it does not lead to mid-size centres. Third, if clusters are not just anticipated, but stimulated by active government policy to lure people into new centre with commodities like electricity - forget it. Migration can not be influenced, unless by brute force. Forth, investing in long living power lines designed to transport electricity to small villages is a queer way to prepare for mid size communities.

11. ELECTIONS

Let us be frank about it: village electrification is a major electoral issue in Suriname's interior: due to the district system the vote of an inhabitant of Sipaliwini carries more weight than the vote of an inhabitant of Paramaribo, and the Bushnegroes and Amerindians have little affinity to Paramaribo issues so their voting behaviour can easily be influenced by handing out presents just before election day. All political parties are very much aware of that and play the trump card of electrification. This has been going on for decades, and by now the promise "this time we will finally do what we have promised many times before" has become a little stale. Promising a new approach is the easiest way out, and many propagandists have claimed that the medium scale power plant is the answer to the problems with village electrification. Which, of course, it is not - but then the politicians win a few years to invent a new dodge. The real problem is organization, and one can easily understand a new government, after inheriting empty coffers, wonder why it should throw away good money just to illuminate a few villages, and put village electrification low on the priority list until the next elections put it on the political agenda again.

12. PUBLIC FUNDS

Why, indeed, should the government use scarce public funds to provide cost free electricity to a select part of the population? This question is a valid one, and in the current situation, the only answer is: historically, this has grown into a privilege, and now it can not be withdrawn without popular discontent - but no one is really happy with the situation.

There can only be two valid reasons why a government should subsidize anything: either it is of public interest that the people should use it, or it provides a breeding ground for development. All other arguments are not really valid.

12.1. NO PUBLIC INTEREST

12.1.1. NO FIRE HAZARD

In urban areas, a century ago, governments did stimulate the use of electricity for illumination: kerosine lamps were too much of a fire hazard, they were known to destroy entire cities. But in the interior villages, this argument is not valid: given the layout of the villages and the build of the huts, fires do occur, but they do not spread, so the fire hazard falls under the individual responsibility; it is not a public affair.

12.1.2. NO HOMEWORK

Another argument often used is that electricity allows children to do their homework at night, and thus electricity does stimulate development. This argument is very much a fabrication. In villages with electricity, one does not see children do their homework at night and there is no statistical evidence that children from electrified villages perform better than un-electrified children. The argument may even be reversed: since the introduction of video-cassette players children spend considerable amounts of time watching television. Not that we seriously put forth this reverse argument, we just use it to illustrate that the homework-argument lacks enough credibility to justify millions and millions of public funds of a not too prosperous nation.

12.2. ECONOMIC DEVELOPMENT

The only potentially valid reason to subsidize electricity for the interior villages is this: it may become a breeding ground for economical development.

12.2.1. DESIGNED FOR ILLUMINATION

In the last sentence above, I used the words "potentially" and "may". I did so with a reason. The way electricity is generated presently, it is worthless for economical development. The installations are designed for illumination, and for nothing else. Only very close to the power house the voltage drop allows the use of electric tools. The generators run from dusk till bedtime, the operators have no instructions how to deal with other requests for electricity. In the huts the government service only installed E27 sockets for bulbs - there are not even power outlets. Some youths constructed power outlets for themselves and bought audio- and video cassette players and refrigerators, but most villagers are obviously ignorant of the fact that electricity can be used for anything else than to replace kerosine lamps. Those people who work with electric power tools, buy their own generators, and the fact that they do not even complain about how ridiculous it is that they have to spend so much money where a potentially useful generator exists, is a very shameful indication of how little the millions spend on electrification stimulates development.

12.2.2. CHICKEN AND EGG

As it is, there is hardly any economic activity in the villages, and the little there is that needs electricity, does not depend on public supply - because there is no usable public supply. And where there is no demand, there is no need for public supply. It is the classical chicken-and-egg question: which one should come first?

In places where industrial development first started - two centuries ago in England, entrepreneurs took the lead, and took care of their power sources, just like the Saamaka pioneers do nowadays - the only difference was that it was steam power in those days - not electricity, but that is irrelevant. They set up their industries, and the government followed suit with infrastructure. It was the chicken first, then the egg. Why should it not be that way in Saamaka?

There are two reasons why not.

The first reason is a matter of speed and comfort. It took the early industries ages to develop, and we don't want to wait that long. And then, it was not a pleasant process. We don't want the inhumanity of nineteenth century capitalism.

The second reason is a matter of competition. The early industries had only craftsmanship to compete, and that was easy. But any Saamaka pioneer industry must compete in a full blown world market, and no novice can fight its way into that without some assistance.

That is why the government should prime the chicken-and-egg cycle. Provided, of course, that the government really wants small industries to start in the villages - which is what I assume, anyway.

Where should one prime the cycle, with the chicken or with the egg? Let us drop the simile now: where should the government help, building infrastructure and wait for entrepreneurs to start using it, or start industries and wait for someone else to build the infrastructure?

The answer to that question should be self-evident, but somehow, it is not. In the transport area, there is a similar chicken-and-egg situation, and when faced with an infrastructure that only allows transport at huge costs, some governments do not invest in good roads, but subsidize a state-owned transport organization to out compete private entrepreneurs. We can only hope that no government (or non-government development organization) will attempt to prime village industries by building a factory big enough to justify its own infrastructure, and subsidize it until it has out competed all private enterprise.

12.3. BREEDING GROUND

To end this paragraph, let me summarize all arguments into this statement: village electrification should be made accessible for small industries. at present it is not. In this study, I compared the various systems for village electrification, and found that only two are feasible in Saamaka (apart from a hydro-electric plant for the villages around Godo): small scale and medium scale diesel generators. I will continue to study how these two solutions fit the problem of powering small industries.

13. ECONOMIC ACTIVITIES

The goal is now income generation in villages, and there are four suggestions for that: agriculture, tourism, lumbering and woodworking.

13.1. AGRICULTURE

Agriculture is mostly a dead end in Saamaka. The soil does not allow for serious production, except at huge costs in labour and environmental damage. Some niches may be feasible: citrus, cacao, tubers, but electricity plays no role in developing these options. So we need not bother about agriculture within the framework of this study.

13.2. TOURISM

Tourism is an option, but it is only a limited option in Saamaka. The main attraction is nature and culture unspoiled by tourism, so tourism has its build-in moderator. For this kind of tourism, electricity is no substantial help: seekers of unspoiled nature are not attracted by electric light.

13.3. LUMBERING

Lumbering is the biggest option, but most of the penalties (environmental damage) and little of the profit will come to the villages. Moreover, public electricity plays no role in developing this option.

13.4. WOODCARVING

The main option for our concern now is woodworking: souvenirs for the tourist trade, and furniture industry.

Souvenirs for the tourist trade is at best a limited option, since tourism itself is a limited option, and hand-carved trinkets loose their exquise-ness if they would become easily available. And technologically, hand carving is a dead-end: primitivist is the main selling point, and the entrepreneur who improves his quality automatically leaves the market. Anyway, electricity does not benefit this industry.

13.5. CARPENTRY

So we should concentrate on carpentry. It has a large added-on value per unit raw material, a moderate reduction of bulk makes processing near the source worthwhile, it is low-technological, needs little capital investment and can start on a small scale - in short, it is the ideal industry for Saamaka. So in this study, I use a small furniture workshop for a model: a unit that needs some five kilowatts of three phase alternating current, and needs it for some 20% of the workday, in periods of typically one hour. This is just an example: other industries with a similar electric demand profile are feasible too: metal construction, confection, food processing and packing.

Electricity is a problem for the furniture maker. In optimal configuration, an own generator is typically 40% of his capital investment and 70% of his machine park's maintenance cost. And then, the kilowatt-hour cost is high, because the transportation costs of the diesel fuel and the moderate efficiency of the small generator. Even with the raw material for his industry near, he can not compete with the Paramaribo based furniture maker, who uses the capital investment that the government already made in public electricity supply. I will now explain how the government can give the village entrepreneur a fair chance for competition.

13.5.1. SMALL SCALE GENERATOR

Suppose there is a small scale entrepreneur in the village, which is serviced by a small scale generator. Suppose that the entrepreneur may use this generator: that there is an adequate power line between the power house and the workshop, that there is a switch that can feed the power to this power line instead of to the village grit, that there is a metre to measure the power consumption of the workshop and that the generator operator received instructions to sell electricity during daylight hours for a reasonable cost price - In know, all this is non-existent, but these are adaptions that can easily be made. In the morning, the furniture maker goes to the powerhouse operator, and tells that he needs electricity for that day. Together they walk to the power house, the operator checks the carter oil level, filters etcetera, switches the output to the workshop, notes the reading of the kWh metre and hands over the generator's crank to the furniture maker. During the workday, the furniture maker starts the generator some five or six times: whenever he uses a planer or saw or whatever, at intervals interrupted by periods in which he marks off material or adjusts the machines - activities that need no electricity, so during these periods he stops the generator. At the end of the working day, he delivers the generator's crank, the operator checks the generator, reads the kWh metre and accepts payment for the used electricity.

This is a perfectly workable arrangement, and it needs only a little additional investment.

13.5.2. MID SCALE GENERATOR

This arrangement works out quite differently in the mid scale generator setup.

First, in a cluster of small villages, there may be more than one entrepreneur who needs electricity on that particular workday. This complicates the job to start and stop the generator. Of course, this may be the case too in a single village, but then - two related entrepreneurs in adjacent workshops can easily work out a modus vivendi.

With a typical distance between workshop and a mid size power generator of half an hour paddling in a dugout, starting and stopping the generator becomes a problem for the entrepreneur. Of course, one can always think up solutions: a telephone line and a permanently present operator in the powerhouse, or a permanent power supply. But this all costs a lot of extra money - permanent power supply becomes feasible only in the large scale option, when the law of averages start working - but this option already proved unfeasible for other reasons.

Then, the switching system to decouple the village grit when the machines are running, becomes more complex, for in the mid-size option the generator can not feed both simultaneously.

Then there is this 100kW generator running to deliver a mere 5 kW output, which is something a diesel engine does not like to do, so the kWh price goes up - etcetera, etcetera.

Of course, for all technical problems In could find solutions, but all solutions cost money and the mid size generator ceases to make a useful infrastructure for economic development.

14. CONCLUSION

Something as complex as electrification of Suriname's interior villages calls for a system that can only be a compromise. The small diesel generators, used presently, are still the best option.

When designing compromises, the engineer should skilfully combine the advantages of all systems. The mis-size generator is not such a compromise: it almost perfectly combines all disadvantages of the small scale and the large scale solutions.