

Document of the Inter-American Development Bank

SURINAME

SUPPORT TO IMPROVE SUSTAINABILITY OF THE ELECTRICITY SERVICE

INVESTMENT LOAN

SU-L1009)

**COMPONENT II –
SUSTAINABLE RURAL ELECTRIFICATION AND INSTITUTIONAL STRENGTHENING**

SOCIO-ENVIRONMENTAL ASSESSMENT POWAKKA

September 4, 2013

This document was prepared by: Remi Rijs, Consultant.

CONTENTS

1. INTRODUCTION 3

2. PROJECT DESCRIPTION..... 3

3. EXPECTED IMPACTS 6

4. DESCRIPTION OF THE PROJECT AREA 9

5. ASSESSMENT OF IDENTIFIED VARIABLES 11

6. HEALTH AND SAFETY 14

ANNEX I. REFERENCES AND INFORMATION SOURCES..... 15

ANNEX II. PICTURES..... 16

1. INTRODUCTION

The general objective of operation SU-L1009 is to contribute to the implementation of a Sustainable Energy Framework for Suriname by strengthening EBS' operational procedures and corporate performance, and by improving the sustainability of rural electricity supply. The three components are: (I) Improvement of EBS' Operations¹; (II) Sustainable Rural Electrification and Institutional Strengthening; and: (III) Critical Infrastructure.

The activities under Component II envisage to achieve: (i) the integration of Powakka village and surrounding communities into the main grid (EPAR) in Suriname; and (ii) the installation of hybrid RE generation to local distribution systems to improve sustainability of electricity supply in Atjoni and nearby communities. Electrification of the Powakka and Atjoni areas is prioritized by the Government of Suriname in order to (i) stabilize demographic development as a prerequisite for future development, (ii) reduce the additional stress on public services in Paramaribo caused by the floating population from the inland, and (iii) directly improving quality of life of the local population, including public services and enabling economic activities.

The present document presents a preliminary assessment of socio-environmental impacts of the works foreseen at Powakka.

2. PROJECT DESCRIPTION

Powakka and the surrounding villages are located about 50-kms south of Paramaribo in the Para District. The power generation is being done by small diesel generators from 5pm to 12pm. The area is easily reached by road from Paramaribo and includes several resorts for leisure and tourism (both national and international). The targeted settlements in the area include the villages of Powakka and Ayo (west of the Suriname river) and Redi Doti and Casipoera (east of the river); and the more disperse dwellers along the main road from Paranam southbound to Afobaka. The total number of connections is about 1,797 with an expected power demand of approx. 5,493-kVA².

In order to upgrade the electrical infrastructure in the Powakka area, four projects have been identified: (i) upgrade Substation (S/S) Paranam; (ii) construction new S/S Powakka; (iii) extension of existing single circuit 33-kV Overhead Line (OH) with 7.4-km between S/S Paranam and S/S Powakka; and (iv)

¹ Component I of the Programme covers: (i) integrating Supervisory Control and Data Acquisition (SCADA) platforms for technical supervision and operation of the power system; and (ii) incorporating business information solutions by financing Information Technologies (IT) hardware and software, such as Enterprise Resources Planning (ERP) and a Geographical Information System (GIS).

² The connections are distributed as follows: Powakka village: 600 (1,839 kVA); Ayo: 52 (174 kVA); Redi Doti: 197 (618 kVA); Casipoera: 79 (255 kVA); communities along Afobaka road: 869 (2,607 kVA). Total: 1,797 (5,493 kVA). The hardware for the distribution system includes: transformers (10x50-kVA, 2x25-kVA), "Amka" distribution cable (3-phase, 3.885-km), 12-kV OH cable (52.183-km), 43 units street lighting, and 700 meter 12-kV underground cable.

new installation of 12-kV and 220V OH from Powakka to Casipoera. EBS has prepared a project document to compare the cost-effectiveness of 24/h diesel-based electricity supply and the upgrading alternative (integration of the area into the EPAR grid)³; a draft environmental management plan has also been submitted⁴.

Scope of Work

1. Upgrade of the existing S/S Paranam (built 1965) by placement of: (i) transformer 50-MVA, 161/33-kV ONAN with OLTC⁵ on existing foundation; (ii) 33-kV switchgear with 5 line bays; and (iii) civil works, transformer foundation and fencing. S/S Paranam is located at the premises of Suralco's bauxite and aluminum industrial complex approx. 40 kms South of Paramaribo.
2. Construction of new S/S Powakka by placement of: (i) transformer 10-MVA, 33/12.6-kV substation; (ii) 33 and 12.6 kV switchgear; and (iii) civil works, transformer foundation and fencing. The projected S/S Powakka is located along the main road from Paranam to Afobaka.
3. Interconnection of S/S Paranam and S/S Powakka, by: (i) extension of the 33-kV, single OH Line from Paranam southbound by 7.4 km to reach S/S Powakka; (ii) installation of 15 new concrete poles for OH-lines⁶.
4. New installation of 12 -kV OH en 220/127-V LV OH lines from S/S Powakka to Ayo (at the west bank of the Suriname River) and the villages Redi Doti, Casipoera and Pierkondre (east of the river) by placement of: (i) 12-kV OH lines SAX, total distance 22.299-km; (ii) 127/220-V LV lines AMAKA, total distance 11.548-km; (iii) 23 transformers, 50 kVA/3-phase; (iv) 2 transformers, 25 kVA/3-phase; (v) 2 transformers, 100 kVA/3-phase; (vi) 27 transformer poles; (vii) 339 units of street lighting; and (viii) civil works, including horizontal directional drilling under the Suriname river for placement of a 12-kV cable.

The scale of the projected works is modest. Part of the works consist of upgrading and extension of already existing infrastructure (upgrade S/S Paranam, OH line S/S Paranam – S/S Powakka, upgrading of distribution system). New infrastructure primarily concerns: (i) site preparation and construction of S/S Powakka; and (ii) installation of underground 12-kV cable underneath the Suriname River.

³ “Upgrade Electrical Infrastructure for Powakka – Redi Doti; Project Scope and Total Cost Estimates”, EBS Project Engineering and Electrical Engineering Department, 13 June, 2013.

⁴ “Upgrade Electrical Infrastructure for Powakka – Redi Doti; Environmental Management Plan”, EBS Dept. Health, Safety, Environment and Quality (HSEQ), June 2013.

⁵ ONAN: Oil Natural – Air Natural (cooling system); OLTC: On-Load Tap Changer (winding taps for voltage control).

⁶ Presently, a 33-kV OH circuit on concrete poles exists between Paranam and Overbridge (distance of 12.6-kms). This circuit is now operated at 12-kV to supply Overbridge. The project plan envisages operating this circuit at 33-kV (which does not require new hardware) and extend it from Overbridge to SS/Powakka (which involves new poles and 33-kV lines over 7.4-km). In order to service Overbridge, a new 12-kV circuit will be placed on the existing poles.

Location

The following map (Figure 1) shows the location of the project area, approx. 50-kms south of Paramaribo.



Figure 1 General location of project area in Suriname.

The following satellite image (Figure 2) indicates the path for the power lines. The red line indicates the 33-kV OH power line between S/S Paranam and S/S Powakka. The black line indicates the 12-kV circuit, which follows the road connecting Powakka, Ayo, Redi Doti and Cassipoera. Near Ayo, this circuit passes underneath the Suriname River.



Figure 2 Trajectory of the 33-kV circuit (red line) and 12-kV circuit (black line).



Figure 3 River crossing of the Powakka Road at Carolina Bridge (Ayo). The width of the Suriname River at this place is approx. 700-m.

3. EXPECTED IMPACTS

Expected social and environmental benefits

Positive socio-economic impacts are expected to benefit the consumers in the project area through the expanded and reliable provision of electricity. The reduction of operational costs contributes to the financial performance of the national electricity company EBS and is supportive to the establishment of a sustainable energy framework in Suriname. Non-financial benefits include: (i) demographic consolidation of communities in East-Para as a result of improved electricity service and sector governance; (ii) verifiable impact of adequate electricity services on education, health, safe water supply and public safety; (iii) local environmental benefits by avoiding the transport, storage and combustion of diesel fuel; and (iv) contribution to mitigation of global climate change by reduced emissions of greenhouse gases compared to the baseline alternative (stand-alone diesel supply).

Potential negative impacts

Factors generating impact on the environment can be temporary (such as resulting from construction and activities) or permanent due to the physical presence and operation of installations. Impacts can be a direct consequence of the planned project activities, or indirect. The impact on the environment can be assessed according to identified variables. EBS proposes the following scale of intensity : (i) major; (ii) moderate; (iii) minor; and (iv) negligible⁷. Major impacts are usually related to irreversible effects and sensitive areas and/or habitats, which is not the case here.

⁷ EBS Report “Upgrade electrical infra structure for Powakka – Redi Doti/ Environmental Management Plan”, June 2013 (p.17).

Since the project seeks promoting development in the area, significant indirect impacts are expected, including: (i) increase of population in the area; (ii) increase of the use of energy and other resources by local households; (iii) expansion of social and economic activities, including tourism, workshops and servicing stations; (iv) increase of waste production in the area; and (v) changes in land use due to demographic and economic development. These indirect effects are outside the scope of this preliminary assessment.

As direct impacts are considered: the permanent or temporary effects of the construction, operation, and decommissioning of the infrastructure defined in the scope of work.

Construction and decommissioning

Construction activities involve transport of equipment into the distribution area (25-kVA, 50-kVA and 100-kVA transformers, cable spools, transformer poles, smaller auxiliary components, and construction material for civil works) using pick-up vehicles and light trucks. A good asphalt road crosses the project area from S/S Powakka to the Suriname River. The transformers and 12-kVA distribution line will be constructed along this road, with only small excursions into the villages to install new service lines (many households are already connected to the present LV diesel grid). The 50-MVA and 10-MVA transformers for the Paranam and Powakka substations are the most bulky and heavy components to be installed under the project. Both substations are located along the Afobaka road, which is commonly used for heavy transport from mining and logging industry. The vehicles will be generally fueled at EBS' premises in Paramaribo. Transport across the river is done by a commercial ferry from Ayo, allowing pick-up vehicles to deliver the material to the east side of the Suriname river⁸. The activities will lead to a temporary increase of traffic in the area. Specific preparations of the roads to allow the entry of the vehicles are not expected, at least not in the dry season. Decommissioning activities would have a comparable character but are not foreseen as the installations will have a permanent character.

Operation

Operation of the projected infrastructure is limited to remote supervision and control (using EBS' SCADA capabilities) and preventive and corrective maintenance. Preventive maintenance includes visual inspection of power lines, connectors, circuit breakers and fuses; and clearing the path of power lines from shrubs, trees and branches. Corrective maintenance includes minor repairs to poles and power lines due to bad weather, lightning, vandalism and accidents. Indirectly, EBS will have more presence in the area related to commercial activities (inspection and connection of households, installation of metering systems, and billing of end-users). Maintenance and commercial activities will involve minor vehicle movements in the area and the presence of EBS' personnel. These activities will be permanent, but are comparable to normal human activity in the area.

⁸ At this site, a bridge (the "Carolinabrug") is being built but has not been completed after it has hit by a barge, causing part of the construction to collapse.

It is concluded that the main impacts of the project are related to the construction and permanent presence of the installations in the physical environment. The significance of these impacts depends on the type of installations and the specific site.

Potential project impact

Five (5) areas can be distinguished that are relevant for the present assessment. These are:

- (1) Substation Paranam. This involves refurbishment of an existing installation located within a large industrial complex (for bauxite mining and processing), which dates back to 1965. Given this context, it is excluded from the present assessment.
- (2) Substation Powakka. This involves a greenfield construction at a site presently covered with woods. The area for the substation is 2500 m² next to the Afobaka Road⁹.
- (3) Power lines Paranam – Powakka. This consists in upgrading of an existing power line over 12.6-kms, and the construction of an additional 7.6-kms. The power line runs parallel to the Afobaka Road at close distance (between 0 and 50-m). This corridor is already in use by the 161-kV HV circuit from Afobaka to Paranam-Paramaribo.
- (4) (a) Distribution lines and transformers in project area Powakka-Ayo. This involves the upgrading and completion of the existing LV diesel grids at the west side of the Suriname River.
(b) Distribution lines and transformers in project area Redi Doti-Casipoera (Carolina district). This involves the upgrading and completion of the existing LV diesel grids at the east side of the Suriname River.
- (5) Suriname River crossing. This project component involves horizontal drilling underneath the river for drawing an underground, 12-kV cable. The crossing distance is approx. 700-m.

Socio-environmental variables

Based on information received from EBS and a field visit to the area (west of Suriname River), the following socio-environmental variables and aspects have been identified, which may be affected by the project:

- (a) status of natural habitats and protected areas;
- (b) endangered species (plants and animals);
- (c) aquifers and surface water (quality and hydrology);
- (d) air quality;
- (e) soil quality;
- (f) land use;
- (g) status of groups (including gender aspects and vulnerable groups); and
- (h) cultural diversity (including archaeological areas).

⁹ Coordinates: (1) 50 25' 29.4"N 550 6'8.4"W; (2) 50 26' 29.7"N 550 6'8.6"W; (3) 50 26' 27.8"N 550 6'8.1"W; (4) 50 26' 28.1"N 550 6'6.5"W.

The project sites are not located in a pristine area, or in a protected area or Natural Reserve, and are generally too small to make up a habitat. It is therefore assumed that potential effects on the natural environment can be evaluated by assessing the impacts on individual plant and animal species.

The project sites are also not considered special in relation to preserving cultural diversity. Archaeological sites have not been identified in the area. Nearby Casipoera is the Jodensavanne, a former Jewish settlement but now abandoned, which has historical importance and certain potential for tourism development. East of the Suriname River, Amerindian people make up a significant share of the population. In order to assess the impact of the project on specific groups, more data needs to be collected. Based on these considerations, the variables (a), (g) and (h) are not analyzed further within the scope of this preliminary assessment.

4. DESCRIPTION OF THE PROJECT AREA

Climate

Suriname has a typical tropical climate with high rainfall and high temperatures. Most rainfall in the region falls in the two rainy seasons, between December and early February; and between mid-April and mid-August. The period between July and October tends to be warmest, with average temperatures of more than 33°C. The period December-March is cooler, around 30°C. Minimum temperatures throughout the year are between 21-23°C. Most of Northern Suriname has a Tropical Rainforest Climate with average annual rainfall ranging between 2,000 and 2,500 mm. Humidity is generally high throughout the year, varying between 80% and 90% on the Coastal Plain and 75% in the Interior. Wind speeds are generally below 5 m/s in Suriname with a predominant easterly and north-easterly wind direction. Suriname is outside the hurricane belt.

Hydrography

The Suriname River flows south–north through central Suriname. It has a catchment area of approx. 16,500 km². with discharges between 220 m³/s in the dry season to 1,800 m³/s in the wet period. Currents in the Suriname River depend on tidal influences and discharges from the Brokopondo Reservoir. Water quality in the Suriname River is variable and generally fresh, becoming increasingly saline further downstream. Saline intrusion can extend to 60-km upstream of the river mouth. Turbidity values are high and unevenly distributed along the length of the river.

Geomorphology and soils

The project area is located on the Para (or Old Marine) scape, the cover landscape and river floodplain (Suriname River). No mineral resources or metals deposits are known in this area. Typical in the area are the fine white sand deposits (the “savannah”) and black water creeks, which attract many people for leisure and day tourism. It is also a valuable raw material for the construction industry.

Land use

The project area is dominated by secondary forest, high swamp forest, high seasonal swamp forest, high dry land forest, savannah and cultivated land. The savannah consists of typical savannah shrubs and Mauritius palms. The land is cultivated by the community and several crops are planted such as plantains, root vegetables and pineapples. Some formerly cultivated areas, including commercial plantations, have been abandoned. Especially along the Afobaka Road, disperse families practice shifting, “slash and burn” cultivation, abandoning small plots of land after some years of use. Along the Powakka road it is apparent that many communities are cultivating the land. Pineapple, plantain and root vegetables such as pomtayer are common. The main infrastructural objects in the area are the Afobaka Road (asphalted, 2-lane) with the parallel 161-kV circuit from Afobaka Dam to Paramaribo, the smaller Powakka Road (also asphalted) and the (collapsed) Carolina Bridge. The villages have a disperse character, consisting of individual houses along the Powakka Road; few houses are located more than 1-2 kilometers inland. Most of the land in the project area is owned (or claimed) by privates.

Plants and animals

Nature and wildlife in Suriname are very rich and, in many areas, undisturbed. There is a general lack of data however to assess and quantify the prevalence of specific plant and animal species (e.g., birds, herptofauna, small mammals). This lack of data also applies to the project sites near Powakka. Being classified as secondary forest, it is assumed that no endangered endemic flora species would be threatened in this area. Information about the presence of large mammals is scarce. Based on interviews with the villagers, animals to be found in the area are frogs, monkeys, deer, hare, savannah fox and armadillo; as well as fish species in Suriname River. Hunting and fishing are common activities by the inhabitants of the area. The “*Hyla fuentei*” frog is supposed to have its habitat only in the Powakka area. However, more research is needed to obtain quantitative data.

Population and human activity

The population in the East-Para area is around 5,500 (1,800 households). About 50% of the people live in the villages and generally have access to electricity for several hours per day. The other 50% live along the Afobaka Road between Overbridge and Powakka without any access to basic facilities (including electricity). Tourism activities take place, which is apparent by the number of recreational facilities that have been created. The Suriname River with its black creeks and savannah sands are attractive to visit during the weekends for people from Paramaribo. Due to the presently inadequate quality of infrastructure and basic services, many residents stay and work in Paramaribo during the week. The bridge to Carolina is an important element to link Central and East Suriname, but is not operational. The small ferry at this site triggers commercial activities (food and small shops) for travelers. It is expected that the supply of 24/h electricity service in the region will boost demographic and economic development with 40% in the first years.

5. ASSESSMENT OF IDENTIFIED VARIABLES

Baseline situation

Due to the small size of the project area, and the lack of site-specific knowledge about the presence of relevant plants and animals, a quantitative description of the baseline situation would need in-depth study. There is also no detailed information concerning present levels of chemical contamination of surface water, river water, and soils, air pollution, and nuisance (such as noise and traffic intensity). As a quantitative appraisal, significant levels of chemical contamination seem unlikely in the baseline situation, but the presence of human activity is quite strong. Specific sources of pollution or chemical contamination are not reported. The construction of the Powakka substation is the only greenfield activity, which requires clearing of 2,500 m² of secondary forest. This area however is already disturbed by the traffic on the Afobaka Road. The corridor along Afobaka Road is mostly cleared from large vegetation as the 161-kV line from Afobaka-Paranam-Paramaribo runs here. The area is used for shifting cultivation by local settlers. The areas along the Powakka Road are basically rural villages, hosting the beneficiaries of the project.

Identification of potential impacts and mitigation measures

The following tables summarize the potential impacts and mitigation measures for the identified variables and for each for the project sites. EBS will be responsible for the monitoring of impacts and implementing adequate mitigation measures. Where appropriate, EBS will require and enforce mitigation measures for subcontracted works¹⁰.

Substation Powakka (10 MVA, 33/12-kVA)		
Variable/aspect	Potential impact	Mitigation measures
(b) endangered species (plants and animals)	No endemic plants identified; Potentially sensitive area for “Hyla fuentei” frog; negative impact unlikely given the small project site; more data needed to assess properly	Updating available data on endemic and endangered species in the area (including “Hyla fuentei”); In case of significant (but unlikely) impact for “Hyla fuentei”: consider compensation of habitat, or site relocation.
(c) aquifers and surface water (quality and hydrology)	No surface water at the project site; Small amounts of oil and chemicals used during construction and operation may reach aquifers; Transformer oils are notably harmful to people and the environment.	Prevention of oil spillage (especially transformer oil) and disposal of waste during construction and operation, by appropriate technical measures and instruction of personnel.

¹⁰ EBS “Upgrade electrical infra structure for Powaka – Redi Doti/ Environmental Management Plan”, June 2013 (p.20-23).

(d) air quality	Negligible impact on air quality	Enforce silencers and proper maintenance of machinery.
(e) soil quality	Soils may be contaminated by small amounts of oil and chemicals used during construction	Prevention of oil spillage and disposal of waste during construction and operation, by appropriate technical measures and instruction of personnel.
(f) land use	2,500 m ² of land would be changed from secondary forest (next to main road) and converted into fenced area used for electrical installation.	None

Power lines Paranam – Powakka (33-kV, 7.6-km)		
Variable/aspect	Potential impact	Mitigation measures
(b) endangered species (plants and animals)	No endemic plants or animals identified; the power line corridor runs along the main road. The area is mostly cleared at this side of the road. The existing 161-kV circuit is located in this corridor.	None
(c) aquifers and surface water (quality and hydrology)	None	None
(d) air quality	None	None
(e) soil quality	None	None
(f) land use	Spots for location of poles. Access to corridor for maintenance (already cleared).	None

Distribution lines and transformers in project area (12-kV and 220-V; 25, 50 and 100-kVA)		
Variable/aspect	Potential impact	Mitigation measures
(b) endangered species (plants and animals)	Not expected, since distribution lines and transformers are placed in an area that is already inhabited.	None
(c) aquifers and surface water (quality and hydrology)	Transformer oil and other chemicals may be spilled during maintenance and reach the aquifers.	Prevention of oil spillage (especially transformer oil) and disposal of waste during construction and operation, by appropriate technical measures and instruction of personnel.
(d) air quality	None	None
(e) soil quality	Transformer oil and other chemicals may be spilled during maintenance and contaminate the	Prevention of oil spillage (especially transformer oil) and disposal of waste during

	soils.	construction and operation, by appropriate technical measures and instruction of personnel.
(f) land use	Negligible, because distribution grids based on diesel electricity are already in place.	None

Suriname River crossing (12-kV cable underneath river)		
Variable/aspect	Potential impact	Mitigation measures
(b) endangered species (plants and animals)	Not expected. Major disturbance due to human activity already occurs at the entry points for the cable (river shore next to Carolina bridge).	None
(c) aquifers and surface water (quality and hydrology)	No adverse effects are expected during operation of the cable. During installation, specialized machinery is used for horizontal drilling under the river bed, using oils and sludge pumps. These may be toxic and contaminate river water and aquifers.	Prevention of oil and sludge spillage and operation, by appropriate technical measures and instruction of personnel.
(d) air quality	No adverse effects expected. Machinery used during installation causes temporary pollution (exhaust smoke) which may cause nuisance to nearby people.	Enforce silencers and proper maintenance of machinery.
(e) soil quality	During installation, specialized machinery is used for horizontal drilling under the river bed, using oils and sludge pumps. These may be toxic contaminate the river bed and the entry sites.	Prevention of oil and sludge spillage and operation, by appropriate technical measures and instruction of personnel.
(f) land use	No changes in land use. Dredging and future exploitation of the river bed for gravel/sand mining would be inhibited.	None

6. HEALTH AND SAFETY

No aspects related to health and public safety have been identified. In general, the provision of grid-quality electricity in the area is expected to bring along positive effects on public health. However, local people may be not familiar with the potential hazards of the HV (12-kV) power systems which are now introduced into the villages. Although such technology is common in other parts of Suriname, some instruction to local people may prove beneficial. The projected installations will comply with international safety standards and best practices as applied by EBS in the EPAR area.

ANNEX I. REFERENCES AND INFORMATION SOURCES

INFORMATION SOURCES POWAKKA	DOCUMENT NAME	SOURCE
Project plan Powakka-Redi Doti	“UPGRADE ELECTRICAL INFRASTRUCTURE FOR CONNECTING POWAKA – REDI DOTI TO THE EBS GRID Rev 13 Jun'13.pdf”	EBS
Drawings projected upgrade distribution grid Powakka-Redi Doti	“LS18162(asbuilt)-V130309 Powakka en omgeving.dwg”	EBS
Basic demographic data from Census 2004	“census profile on ressort level.xls”	FOB
Excel spreadsheet by EBS on costs and revenues in Powakka	“Cost Estimate Distribution Powakka Area.xls”	EBS
Estimate by EBS of costs and revenues in Powakka	“O&M and Revenues Powakka_Redi Doti.xls”	EBS
Field survey households Powakka – Redi Doti by EBS	“Overzicht van het gebied Powakka.xls”	EBS
Field survey ressort Carolina, by FOB	“Ressort carolina.doc”	FOB
EBS Report “Upgrade Electrical Infrastructure for Powaka – Redi Doti - Environmental Management Plan”	“EMP Powakka _ final6142013_3.51pm.doc”	EBS
EBS Project Identification Form Substation Powakka	“EBS Project identification form – Substations.pdf”	EBS
Pictures of Project Area	“Photos Powakka Area.doc”	EBS
Other sources		
Pictures taken by consultant		

ANNEX II. PICTURES

(1) Substation Paranam



Figure 4 Substation Paranam located at Suralco's bauxite mining and processing complex.

(2) Substation Powakka



Figure 5 Projected location of Substation Powakka (2,500 m²) next to Afobaka Road (where cars are parked). The vegetation at this side of the road is secondary forest.

(3) Power lines Paranam – Powakka



Figure 6 Afobaka Road between Paranam and Powakka. The corridor is already in use by the 161-kV HV circuit from Afobaka to Paranam-Paramaribo.



Figure 7 Part of the 33-kV circuit Paranam-Overbridge (presently operated at 12-kV). This circuit would need to be extended from Overbridge to Substation Powakka.

(4) Distribution lines and transformers in project area Powakka-Ayo.



Figure 8 Typical house in Powakka, and the present LV distribution grid.



Figure 9 Diesel-operated water pumping system in Powakka.



Figure 10 Medical post in Powakka

(5) Suriname River crossing



Figure 11 Suriname river at Ayo with the collapsed Carolina Bridge and the present ferry transfer (view towards eastern shore).



Figure 12 Barge with construction material (savannah sand) on Suriname River near Ayo.

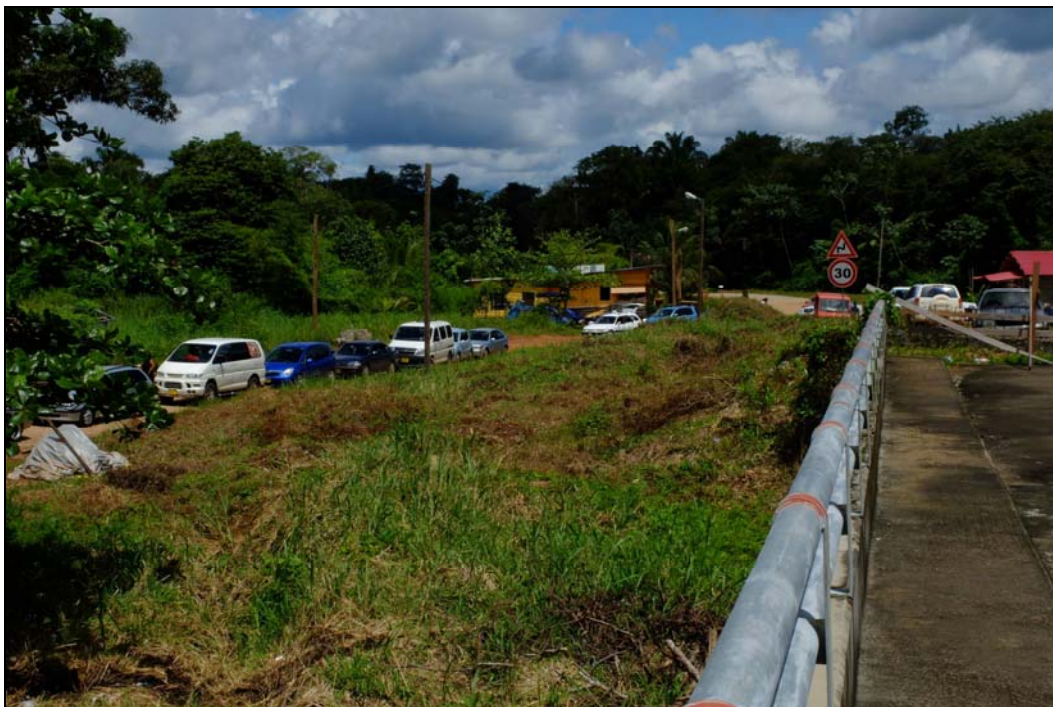


Figure 13 People at Ayo waiting for the ferry to cross the river.