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STRATEGIC ENVIRONMENTAL ASSESSMENT

of

REPLICATION OF THE PROJECT COMBATING BUSH ENCROACHMENT FOR NAMIBIA'S DEVELOPMENT (CBEND, CONTRACT NO RPRP-123022-34)

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EXECUTIVE SUMMARY

1. Introduction

The Desert Research Foundation of Namibia (DRFN) is implementing a project entitled "Combating Bush Encroachment for Namibia's Development" (CBEND). Bush encroachment on approximately 26 million hectares has affected much of Namibia's rangelands, with the result that cattle farming has been badly affected by loss of grazing capacity. Once grassland savannas have been taken over by bush, some form of intervention is needed to restore an area to productive rangeland.

One of the major problems for farmers is the cost of bush clearing in relation to the benefits obtained. In order to help give bush harvesting a value, CBEND envisages that numerous small electricity generating plants will be set up within the bush encroached areas of Namibia. The main objective is to help restore the productivity of rangelands, and electricity generation helps to achieve some cost recovery, even though the amount of electricity generated is expected to be only a small percentage of the national power demand. The project is conceived in the national interest for the overall benefits it seeks to deliver, namely:

- Restoration of productive rangelands that are currently bush encroached,
- Supply of electricity into the national grid, using local, indigenous, renewable fuel,
- Employment creation and opportunities for small bush harvesting enterprises,
- The establishment of commercially operated small Independent Power Producers (IPPs).

A pilot plant, of 0.25 MW generating capacity, is being established on a farm north of Otjiwarongo. The technology involves a gasifier plant that converts wood to gas, which is then used in an electricity generation plant. The fuel used will be encroacher bush. The power will be purchased by the national utility companies. Harvesting will preferably be done by hand in order to optimize employment creation, but machine harvesting is a possible alternative or supplementary option. If the pilot plant proves successful, these plants could be replicated all over the bush encroached parts of Namibia. It was previously estimated that up to 300 power plants could be established, each with a capacity between 200 kW and 500 kW. This assessment places some environmental constraints on total generation and brings the maximum number of plants down to about 160.

This Strategic Environmental Assessment (SEA) assesses the likely outcomes of replication of the CBEND model in terms of its cumulative biophysical and socio-economic impacts and sustainability. Specifically the SEA aims to:

- Predict the cumulative effects of large-scale replication of the CBEND concept,
- Identify the magnitude and significance of environmental (= biophysical *and* socio-economic) impacts,
- Assess possible risks associated with a large-scale replication of the CBEND concept,
- Identify measures to mitigate adverse environmental impacts,
- Understand the concerns of key stakeholders and interested parties,
- Summarise the institutional implications of programme and policy interventions by the Namibian government to support bush-to-electricity initiatives.

2. Background and methodology of the SEA

Whereas Environmental Impact Assessments (EIAs) usually assess the impacts of individual projects, Strategic Environmental Assessments (SEAs) are able to assess the combined (cumulative) impacts of many similar projects. The SEA identifies important biophysical and socio-economic issues that can be addressed in advance of large scale replication.

The methodology used included:

- literature research,
- requests for information from government (only partly successful),
- information on charcoal producers from the Directorate of Forestry (incomplete),
- consultation with farmers in the Otjiwarongo, Otavi, and Grootfontein areas,
- discussions with officials in NamPower, Electricity Control Board (ECB), Directorate of Forestry (MAWF), and Directorate of Resettlement (MLR), and
- a workshop to solicit expert opinion on relevant themes.
- A feedback workshop to allow stakeholders to comment on the draft report

The distinction must be made between the CBEND pilot plant that is operating on farm Pierre, and the replication of CBEND-like plants and the CBEND concept that is the focus of this SEA. Where there may be confusion, we use the term CBEND-like plants or the CBEND concept to describe the plants that may be replicated in future.

The SEA was limited mainly by the pilot plant not yet being installed. Primary field research was not included, but a field trip was conducted for familiarisation with the affected areas. The technology has been tried and proven in other parts of the world, but information is needed from the pilot plant relating to economic feasibility, technical constraints and chemical analysis of waste products. Another limitation was a lack of detailed maps of bush encroached areas.

3. Programme description

This describes the CBEND pilot project being run by DRFN. If and when the CBEND pilot plant proves its viability, some of the steps (e.g. establishment of a steering committee and trust) will not be necessary for future CBEND plants, but the lessons of the pilot plant's Management Committee, Steering Committee and Trust will inform future replication. The plant specifications are the basis of a typical CBEND plant that could be replicated.

The direct beneficiaries of the CBEND project will be chosen from emerging commercial farmers of Namibia's Land Reform Process. The harvesting and production activities will take place on or close to resettlement farms depending on bush density, access to the national electricity grid and the ability and willingness of farmers to participate.

The programme involves the following tasks:

- Establish a Project Management Unit (PMU) for overall implementation of the CBEND concept, guided by a Project Steering Committee. The project has established a Trust that is the long term owner of the gasification equipment to oversee its use. A strong and effective Trust is necessary to manage the plant through the IPP.
- Establish Namibia's first Independent Power Producer (IPP). The Trust leases the equipment to the IPP. The IPP was selected on the basis of a public tender process.
- Secure a wood harvesting permit to comply with Forestry regulations, and comply with requirements of the ECB and Regional Electricity Distributor with regard to a Power Purchasing Agreement.

- The PMU has procured the gasification technology and is overseeing its installation. It will provide training to the IPP, to farmers regarding bush harvesting and aftercare management of rangelands, and establish operational procedures for the power plant and harvesting procedures.
- Monitor the performance of the IPP contractor – to inform further replication of the project.
- Make recommendations for amending existing policies to encourage replication.
- Create awareness of the CBEND opportunity amongst SMEs.

Specifications for a typical CBEND plant

Specifications for a typical CBEND plant are set out in the table below for a 250 kW plant. Fuel and waste production can be scaled up proportionately for plants up to 1 MW.

Criterion	**Specification**
Maximum distance to power line	500 m
Capacity of power line to feed in to	11 / 22 / 33 Kv
Typical producer gas composition	N_2 – 50%; CO – 19±3%; H_2 – 18±2%; CO_2 – 10±3% CH_4 – up to 3%
Generation capacity	250 kW
Fuel requirement	1,550 t wood/a = 6.5 t wood / day
Water requirement for evaporative cooling	16,000 l/day
Area of harvesting over 1 year, at take-off = 2 t/ha	780 ha
'Exclusive area' for harvesting around power plant, for ~ 50% bush clearing over 10 years (excludes re-growth and/or aftercare)	4,000 ha
Solid waste production	800 kg tar-contaminated sawdust every 20 days. Fed back to gasifier
Ash and biochar production	Ash – 300 kg/day Char – 200 kg/day
Tar sludge production	500 l/day, which can be re-used
Brine waste product (from water softening, if applicable)	300 l/day
Capital cost of gasifier and establishment of plant (2010 prices) and wood processing and handling equipment	N$ 9 million
Expected life of plant (with regular replacement of wear and tear components)	20 years

Labour requirements for a typical CBEND power plant, not linked to a charcoal operation, are set out below.

Labour class	**8 hour shift (morning)**	**8 hour shift (afternoon - evening)**	**Total**
Plant Manager (skilled)			1
Foremen (semi-skilled)	2	2	4
Tractor driver (semi-skilled)	1	0	1
Plant operators (labourers)	4	4	8
Bush gatherers (labourers)	4	0	4
Bush cutters (labourers)	8	0	8
Total			26

Harvesting for a CBEND operation could be linked to harvesting for a charcoaling operation, as they use different sizes of bush stems. In that case, the labour requirements for cutting for CBEND would be reduced.

It must be emphasized that the process of bush harvesting would be selective – targeting the encroacher species, and leaving large trees, browser species and bush clumps. In recognition of the importance of trees and bush to maintain soil fertility and encourage the growth of the more nutritious grasses, the approach will be one of bush thinning, not bush eradication. This approach is in line with the draft Bush Encroachment Policy of Namibia and the draft Rangeland Management Strategy.

4. Programme alternatives

4.1 Alternative uses of encroacher bush

Alternative technologies for the economical use of bush were subjected to a Cost Benefit Analysis by Honsbein and Joubert (2009). Based on specific assumptions, it was found that bush clearing/thinning merely to improve rangeland productivity is economically marginal. Therefore it is important to achieve some cost recovery from the sale of bush. The study found that the two most viable options are charcoal production and small-scale gasification for electricity generation (i.e. the CBEND concept).

Charcoal production
The charcoal industry in Namibia was worth N$ 75–100 million (in 2004) and continues to grow, with 200-300 farming operations involved in this activity. Estimates on the amount of charcoal produced in Namibia vary from 50,000 to 90,000 tonnes per year. Farmers interviewed stated that charcoal has proven itself as a profitable and sustainable industry, but has unique labour-related challenges.

Harvesting bush for charcoal is mostly done manually, which is extremely taxing work. Most cutters are from Kavango and work on a contract basis, not as full-time employees. Despite the relatively good income from bush cutting compared to other farm worker tasks, it is not easy to find committed bush cutters and charcoal farmers talk of the need to continually recruit new labourers for this task.

A problem with charcoal production is that indiscriminate harvesting of wood is alleged to take place, especially cutting of large and/or protected trees which produce more wood per unit effort. The emphasis on labour-intensive harvesting possibly exacerbates this situation. Farmers were of the opinion that regulation and policing of the industry by the Directorate of Forestry is inadequate to prevent this kind of abuse of the resource. Strict enforcement of forest-friendly harvesting principles, as laid down by the Forestry Stewardship Council (FSC), is necessary to prevent this. Many charcoal farmers obtain FSC certification as they can achieve a higher price for their product, but many others do not.

Charcoal production in Namibia is done using simple kilns, which are easy to operate and appropriate to the local farm conditions. There is limited scope for the use of advanced kiln technology, due to the high cost.

Bush for firewood
Wood sold as a domestic cooking fuel can be an economic alternative for farmers who want to clear bush on a large scale. The price of firewood in rural areas is quite low, but it can fetch higher prices in Windhoek and still higher if exported to South Africa and the European Union. While harvesting firewood can target encroacher species such as mopane, sicklebush and purple terminalia, non-encroachers (e.g. camelthorn) are often sold locally for the leisure market. Harvesting of the latter can therefore not be considered as a method to combat bush encroachment; nevertheless, harvesting of the encroacher species for this sector of the market is significant.

Poles and droppers
This is a very small market. Some farmers, in the process of charcoal harvesting, select long thin poles (especially from mopane and silver terminalia), treat them against insect attack, and sell to small, local markets.

Extruded wood logs ('Bushbloks')
This is carried out by Cheetah Conservation Fund (CCF), and the operation covers a relatively small area (few hundred hectares) to feed a factory in Otjiwarongo. The main objective is to thin encroacher bush on the CCF farm to enhance the habitat for cheetah. The enterprise is small and not likely to expand.

Other products from encroachment bush, such as pelletizing for use as a co-combustion fuel for electricity generation, wood chip briquettes and composite wood products, have limited financial viability in Namibia and/or limited potential.

CBEND in conjunction with charcoal production and/or other bush industries
The CBEND concept is fully complementary with charcoal production and other bush industries such as manufacture of fence droppers and firewood sales. Relatively thicker branches can be turned into charcoal, firewood or droppers, and smaller pieces (wood chips) can be used for wood gasification. This synergy also offers the benefit that the farmer already has systems in place for management of labour, which can relatively easily be extended to a CBEND operation.

4.2 Alternative methods of clearing encroacher bush

Various methods for bush management are in practice, such as manual cutting, mechanical clearing (using bulldozers or dedicated bush-cutting machinery), use of arboricides (selectively or by aerial spraying), burning and biological control.

Bush thinning by hand compares well in terms of its relatively small environmental impact. Hand labour, if well supervised, can be highly selective, targeting problematic bushes and trees and leaving grass and desirable plants, to create optimum 'savanna-like' rangeland. However this is physically very strenuous and demanding work, and supervision and management of cutting teams (necessary to prevent cutting of the wrong trees) takes up a large proportion of the total bush-clearing effort.

Mechanical clearing involves much less management, but is more expensive. Bulldozer-like machinery is generally wasteful and damaging to the soil, and causes vigorous regrowth of bush. The large-scale bush clearing machinery proposed to clear bush for fueling the Ohorongo cement factory is selective and efficient, yet very capital intensive so uneconomical for bush thinning at the CBEND scale. Smaller-scale machinery such as a cutter-head on an excavator machine can be very selective and, operated properly, needs inflict no damage to the soil. Environmentally this has no negative impacts.

Arboricides are widely used and are sold at cost to farmers by the Meat Board. Of particular concern is the aerial application of arboricides, which kills all woody plants including protected species and those trees which are beneficial to rangeland health. Application of arboricides by hand is more selective and preferable as it is more labour-intensive, but can also kill desirable trees. Although these arboricides are reputed to be non-toxic to fauna, the use of chemicals always poses the risk of unforeseen negative impacts. Whether toxic or not, caution should be taken in application of arboricides to avoid killing useful and protected trees.

Burning is not widely practiced, and biological control using a fungus to kill encroacher bush has had very limited success.

For CBEND, it is preferable that bush should not be killed before it is harvested, as this makes the wood hard and more difficult to cut. To summarise bush clearing methods: manual and small-scale mechanical harvesting methods are the most appropriate for the CBEND concept, and are best suited to thinning rather than clearing of bush, which fits the aim of restoring rangelands to a savanna-like condition.

The importance of aftercare is emphasized in the literature and the Bush Encroachment Policy. Various methods are in use to manage the regrowth of bush following harvesting. These include hand application of arboricides, stem burning, intensive browsing by goats or antelope and judicious use of fire.

4.3 Power generation alternatives

CBEND represents a relatively small contribution to Namibia's current electricity demand of 517 MW, even at the most optimistic scenario of maximum replication generating 40 MW. Nevertheless, policy objectives in Namibia are to meet peak demand and 75% of total demand from sources within Namibia by 2012. At present, Namibia imports almost half of its electricity requirement from neighbouring countries in the Southern African Power Pool. Thus Namibia must urgently increase internal generation capacity. Furthermore, NamPower established a target of 10% renewable energy capacity by 2011 (excluding the Ruacana run-of-river hydro plant), focusing on selected technologies (including invader bush), with the first target of 40 MW to be generated from renewables by 2011. In this light, the CBEND concept could make a significant contribution to the country's energy needs and progress towards Vision 2030.

The advantage of renewable energy generation is that small scale operations can be established relatively quickly compared to the long lead times necessary for larger power stations. Replication of many CBEND-like operations could, given the right market incentives and NamPower support, take just a few years to make the contribution that the Energy White Paper desires.

4.4 CBEND, carbon trading and the REDD programme

The issue of carbon trading has not been investigated since the small size of CBEND-like projects will not be worth the enormous administrative procedure and high costs that go with the Clean Development Mechanism.

The CBEND concept might appear to run contrary to the UN REDD programme (Reduced Emmissions from Deforestation and Forest Degradation) which promotes maintaining forests for their role as a carbon sink. As justification for CBEND, it must be noted that REDD is a programme aiming to protect forested areas from logging; it does not intend to stop the restoration of savannas that have become bush encroached.

5. Baseline scenario

5.1 Biophysical aspects

Bush encroachment is defined as "*the invasion and/or thickening of aggressive undesired woody species resulting in an imbalance of the grass : bush ratio, a decrease in biodiversity, and a decrease in carrying capacity and concomitant economic losses*".

Some of the salient features of the natural environments affected by bush encroachment are:-

- The bush encroached areas are mostly in the higher rainfall areas in the central and northern half of Namibia (Figure 5.1). The encroached area in Hardap and Karas Regions has no CBEND potential as the encroacher plant is a low bush with inadequate biomass.

- Most of the worst bush encroached areas are on plains rather than steep hills and mountains, partly due to higher grazing pressure on the plains.
- Soils are poorly developed and intrinsically low in nutrients.
- Soil fertility may decline if too much bush and trees are removed. The approach to utilizing bush should be bush thinning rather than bush clearing.

It is estimated that approximately 26 million hectares in Namibia suffer bush densities between 2,000 and 10,000 bushes per hectare, although that figure stems from work done in the 1990s and is likely to be higher now. Preliminary work for CBEND by DRFN estimated that 10 tonnes/ha could be harvested from some 10 million hectares. Thus they estimated the standing crop at roughly 100 million tonnes that could potentially be harvested.

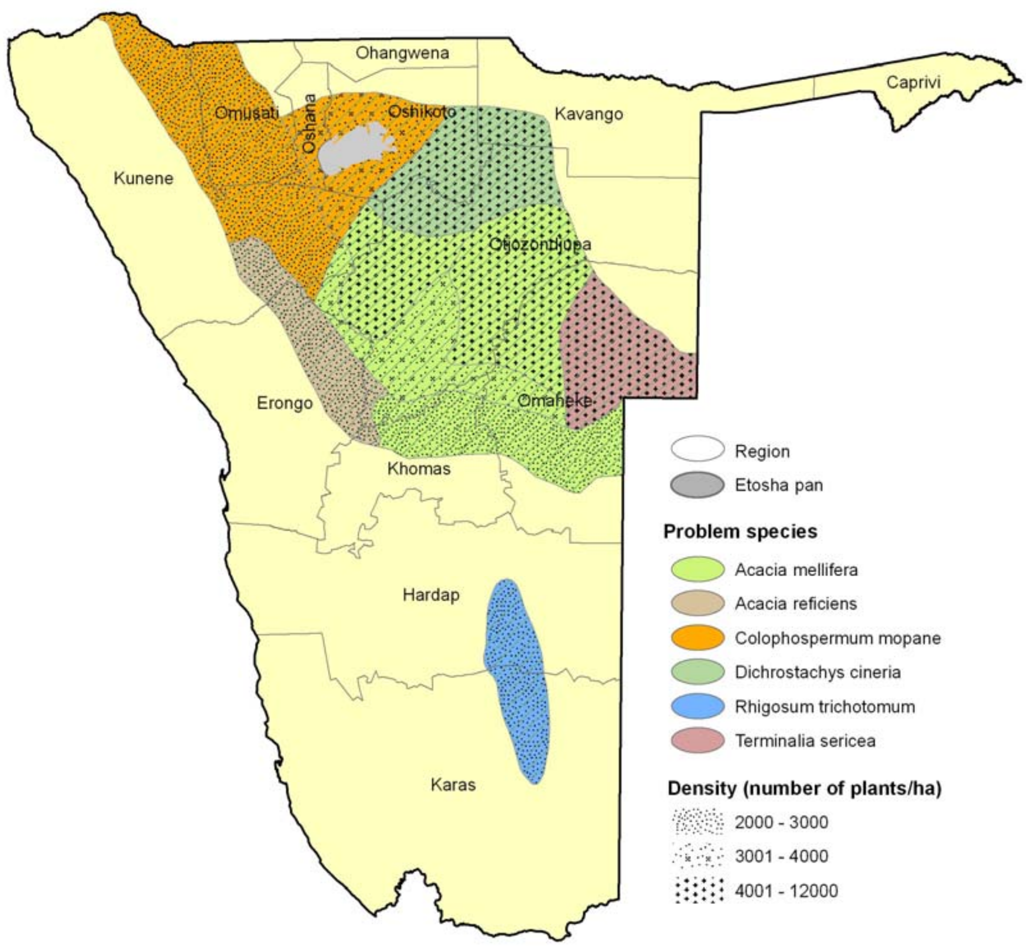

Figure 5.1: Distribution of the dominant species of encroacher bush in Namibia (after Bester 1996).

Appendices to this report provide lists of those trees and bushes that are pertinent to the encroachment problem and rangeland health. Only **encroacher species** should be targeted for harvesting. Valuable **browser species** should be retained for their value to browsing wildlife and goats, and for cattle in times of drought. By law, **protected species** may not be harvested.

Different encroacher bush species respond differently to being cut. Most regrow from stumps, so there is a natural tendency for bush to regenerate after clearing. Prolific seeds dispersed from *Acacia mellifera* (blackthorn) do not stay viable for more than one season, so regeneration of this species is relatively easy to control. In contrast, the seeds of *Dichrostachys cinerea* (sicklebush) stay viable for a few years and this species therefore grows back even more densely after clearing.

Bush encroachment is considered a threat to biodiversity. In affected areas the number of species of plants, birds, mammals and reptiles is lower than in healthy open savannas. However, at the other extreme, if all trees and bush are cleared, then species diversity declines again. In general, open savanna, with scattered large trees, browser species and clumps of bush, and abundant grass cover comprising mostly perennial grasses, tends to optimize biodiversity. Several species of conservation importance – mostly birds of prey - are likely to benefit from bush thinning as proposed by CBEND.

5.2 Socio-economic aspects

The CBEND concept has the potential to help reduce poverty in Namibia's rural areas through the provision of jobs and developing bush-harvesting SMEs. Various socio-economic factors affect the need for employment creation, the labour supply situation and the distribution of economic wellbeing in Namibia. .

Rural areas experience far greater levels of poverty than urban areas, and far lower levels of education. The highest incidence of poverty is found in the Kavango region, where over half the population is classified as are poor. Kavango is also home to the greatest percentage of all poor households in the country. More than 60% of all poor households in Namibia are found in the combined regions of Kavango, Ohangwena, Oshikoto and Omusati.

Unemployment in Namibia in 2008 was 51.2%.

Large differences exist regarding educational attainment between rural and urban populations. 23% of the population in rural areas have no formal education compared to 7% in urban areas, and the average per capita earnings in urban areas is considerably higher than in rural areas.

Poverty levels in Namibia are highest among rural households that are female-headed. On average women earn 30% less than men in rural areas and 40% less than men in urban areas.

National prevalence of HIV/Aids is currently 17.8%, but the disease is concentrated amongst mobile populations (e.g. those linked to the mining industry). No data was available on the incidence of HIV/Aids amongst charcoal workers (and therefore, potential CBEND workers) but it is assumed that this is also a high risk group as they tend to be transient. The average HIV/Aids prevalence in the combined communal regions where there is bush encroachment (roughly 20%) is higher than the national average and considerably higher than in the encroached freehold farming areas (14%).

Resettlement farms experience a number of economic and social ills and many of them are densely bush encroached. The CBEND concept represents an opportunity to provide some of these communities with improved employment opportunities to harvest bush, improved livestock production, electricity, and power to operate pumps for water boreholes.

Since many resettlement farms are situated in Namibia's most bush encroached areas, the above descriptions would give the impression that resettlement farms are an obvious target for the labour creation that CBEND proposes. However there is a concern that although many resettled farmers are struggling, they may be unwilling to engage in the type of manual bush clearing activities that CBEND involves. An advantage of the CBEND concept is that the operation provides opportunities for women in the less physically demanding tasks.

5.3 Electricity baseline

One of the most important criteria for grid infeeding is the proximity to an appropriate powerline, of capacity up to 33 kV. The current network of 11, 22 and 33 kV lines covers the most densely populated parts of the northern communal areas as well as most of the freehold farming areas in central Namibia (Figure 5.6).

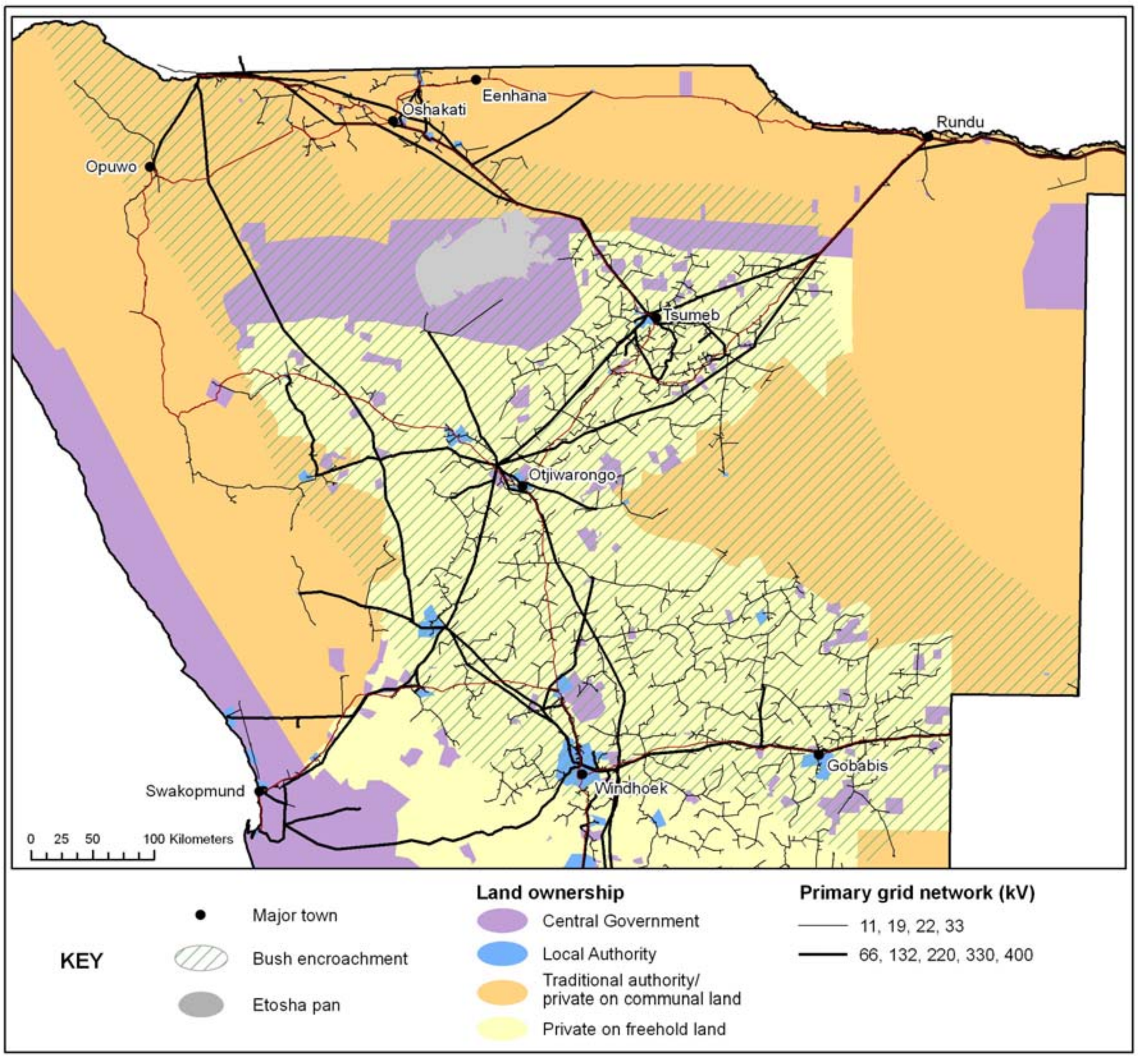

Figure 5.6 Bush encroachment in northern Namibia mapped against State land and communal and freehold farming areas, and the network of powerlines that can accept electricity infeeding.

The dynamics of each rural electricity reticulation system is unique in terms of technical aspects such as the load factor and efficiency. From NamPower's perspective, CBEND plants should ideally be located closer to, rather than further from, substations to minimize the instabilities that infeeding can bring.

5.4 Policies and legislation

The relevant laws affecting CBEND operations include the following:

- The Environmental Management Act, emphasizing protection of Namibia's natural heritage and the need for the precautionary principle when development might negatively affect it;
- The Forest Act, which regulates cutting and transportation of wood through permits, and prohibits cutting of those species listed as protected;
- The Nature Conservation Ordinance, which also lists certain tree species as protected;
- The Labour Act which regulates employment conditions and safety precautions for employees;
- The Electricity Act which regulates the generation and sale of power through licence agreements with Independent Power Producers.

A number of policies promote sustainable use of natural resources, agricultural productivity and poverty reduction. In particular, the National Agricultural Policy will "establish mechanisms to support farmers in combating bush encroachment effectively over the short and long term". Also, the Namibian White Paper on Energy Policy emphasizes the development of renewable energy resources together with social upliftment, investment and competitiveness in economic growth.

The policy framework is therefore fully supportive of the CBEND concept and combating bush encroachment in the national interest.

6 Stakeholder concerns

6.1 Bush encroachment, rangeland and 'bush farming' concerns

Most stakeholders agree that bush encroachment must be combated, but there are differing approaches and levels of commitment to achieving this.

- Some farmers ignore it, suffer lower land productivity but compensate with wildlife and ecotourism enterprises which is less affected by the problem.
- Some wish to debush to restore the ecological integrity of open savanna and to focus on cattle farming. They regard charcoal or CBEND or other economic activities as a means to an end, i.e. to improve land for cattle farming.
- Some have the aim to make money from the bush (through charcoal or other bush products) and therefore wish to sustain it as a lasting resource. The overall opinion was that there is adequate bush, and tendency for bush to regrow, to sustain charcoal operations indefinitely, and that the resource could accommodate CBEND replication as well.

No stakeholders consulted during the SEA were opposed to the CBEND concept but doubts were expressed about its viability in view of the very high capital investment cost.

6.2 Biophysical concerns

There is the concern that harvesting of encroacher bush is removing many old, large, non-encroacher trees, as well as protected trees, and that CBEND will cause this illegal activity to increase. The lack of capacity of DoF to prevent such practice is addressed in point 6.5.

6.3 Socio-economic concerns

Labour issues around the CBEND concept were assessed by looking at the charcoal industry which runs a generally similar operation in terms of labour.

- The majority of bush cutters come from Kavango. Charcoal workers are mostly self-employed, working on informal contracts with farmers and being paid per tonne of wood harvested or charcoal produced. The work is physically very demanding but can be rewarded with income considerably higher than other farm workers receiving a minimum wage.
- Most cutters live in poor conditions, often in remote situations with little access to services such as shops or health facilities. About a third are accompanied by their family; the remainder are not and they are prone to family disruptions, STDs and alcohol problems.
- Many workers regard themselves as exploited and few cutters stay with one farmer for many years.
- Farmers or land owners are generally reluctant to take on the labour problems that charcoal production involves, and this is regarded as a major reason why charcoaling is not more widespread. Farmers spend a lot of time and effort every year recruiting cutters, sorting out their issues, and keeping up with the administrative requirements of the Labour Act.
- Farm workers are reluctant to do bush cutting work. This was reported by farmers, a government worker involved in management of cutting firebreaks, and people acquainted with resettlement farms.
- The Labour Act stipulates a range of conditions that farm employers must abide to, but many of which are not pragmatic for the charcoal situation. In such a case exemption must be sought and can be granted by the Ministry of Labour. The charcoal industry is in the process of negotiating such an agreement involving NAU, NNFU, trade unions and the government.

Despite the NAU guidelines for bush cutting labour, the general opinion is that the Labour Act is a disincentive for labour-intensive activities on farms, and that most farmers would be reluctant to establish CBEND-like operations because of the anticipated labour complications. There will need to be strong incentives for CBEND replication to overcome this reluctance.

The labour situation for a CBEND operation is better than for charcoal as there is a greater diversity of tasks, including semi-skilled and skilled positions, with opportunities for employing women.

6.4 Concerns about the economics of CBEND

The high capital cost of a 250 kW CBEND plant is seen to be the largest obstacle to CBEND replication. Many stakeholders believe that government should provide incentives to make debushing more financially viable, through support for the capital outlay of wood enterprises, soft loans or grants. There was agreement during the workshop that an infeeding subsidy would be the cleanest and most efficient form of financial assistance to CBEND entrepreneurs, similar to the way other governments subsidise grid infeeding as an incentive to encourage decentralized renewable energy generation.

6.5 Concerns about the regulatory framework and GRN capacity

Many stakeholders feel that control and regulation of the wood cutting industry is inadequate, and there are allegations that the charcoal industry is taking out a disproportionate number of large trees rather than concentrating on bush. CBEND replication raises the possibility of this situation getting worse.

Is a CBEND entrepreneur at risk of being denied harvesting permits, thus stopping operation of the plant? Directorate of Forestry officials are adamant that the 6-month period of a harvesting will not be extended, since it is their only means to prevent unsustainable bush harvesting. We suggest that an Environmental Contract between a CBEND IPP and the government will facilitate compliance with government regulations and monitoring of the harvesting activities of a CBEND operation.

Similar concerns arise with respect to the Generation Licence and dealing with the REDs. We suggest these issues should be resolved during the pilot project to ensure that problems do not arise during future CBEND replication.

6.6 Technical concerns

NamPower and Regional Electricity Distributors such as Cenored and Nored are concerned that many small-scale generators feeding electricity into the grid will cause instability in the network. This is due to the inherently complicated and sensitive nature of grid connections, synchronizing the infed electricity, line protection and 'power factor' problems. Generation by a CBEND IPP should aim to be 'embedded' i.e. the electricity it generates is used entirely by consumers in the local distribution line, without any excess that would go into the transmission grid. Tariffs and 'wheeling charges' also need to be addressed. While the ECB tariff policy is in place, a lot of uncertainty remains about the application of the tariff, especially for small donor-funded plants.

Although NamPower officially welcomes any source of alternative or renewable generation, NamPower staff stated that the amount of technical and administrative input required to accommodate several 250 kW IPPs is much greater, and the potential for grid instability is greater, than for a few IPPs generating 5 MW or more. Hence their preference for relatively fewer and larger IPPs.

7 Cumulative impact assessment and mitigation measures

7.1 The envisaged CBEND scenario for roll-out

The maximum number of CBEND plants anticipated in widespread replication prior to this SEA was quoted as 300. Three factors have a bearing on replication of CBEND plants for grid infeeding:

- Proximity of appropriate powerlines,
- Steepness of the terrain on which bush can be harvested,
- Groundwater potential to supply the 16 m^3 daily water demand of a CBEND plant.

These technical and environmental constraints reduce the maximum number of 250 kW CBEND plants to between 60 and 160. The higher figure is used to assess the cumulative impact of replication of CBEND plants in the assessment which follows.

7.2 Positive biophysical impacts

CBEND's most significant positive impact on Namibia's power sector is that the fuel is a locally available, renewable resource and electricity can be generated at flexible times. It therefore starts to fulfill three of NamPower's targets:

- to generate 10% of the total power requirement from renewables,
- from sources within Namibia,

- to meet the full peak demand.

It also reduces the need for the country to use non-renewable fuels for its power, which reduces the net gain of CO_2 to the atmosphere.

Two major benefits from widespread replication of CBEND plants are the improvement in rangeland productivity and groundwater resources. These in turn will lead to improved biodiversity status and integrity of the savanna ecosystems. Additionally, there is likely to be a positive spinoff in the sense of place and aesthetic value of Namibia's savanna areas, which are beneficial to Namibians and visiting tourists alike.

7.3 Negative biophysical impacts and suggested mitigatory actions

The large daily water requirement of a CBEND plant places a limitation on where plants can be established, and is a heavy drain on groundwater resources. Sustained availability of groundwater should be thoroughly checked before any CBEND plant is established. The optimum mitigation would be to make productive use of the available heat, since utilizing heat for other activities would reduce the water cooling needs. The cumulative impact is not likely to be a significant threat, so long as individual CBEND plants have an assured supply of groundwater.

Pollutants from the CBEND-like plants are potentially very toxic. The main culprit is the tar, but there is a possibility that this will not be as toxic as predicted. This needs to be properly ascertained from the pilot plant. If it is, then this constitutes a major environmental impact from widespread replication, and proper waste disposal procedures to hazardous waste sites must be arranged. The other wastes – contaminated water, ash and brine – are much less toxic and easily disposed of at individual CBEND farms.

The increase in wood harvesting for many CBENDs raises the likelihood of the wrong trees being cut, particularly protected species and large trees which perform important ecological functions relative to smaller ones. The cumulative impact of widespread cutting of valuable and protected species could be significant. Prevention places a heavy responsibility on DoF officials to ensure that cutting and harvesting procedures are carried out properly, and training for this purpose should be mandatory for all cutters.

Soil erosion could become more prevalent on slopes if CBEND-like operations do harvest on relatively steep (>5%) gradients. This practice is discouraged. Cumulatively, relatively few areas of heavy bush encroachment are on steep ground, so the impact is likely to be small even if the suggestion to not harvest such slopes is ignored.

Soil fertility declines when bush is cleared rather than thinned. Bush clearing is not the intended practice in CBEND replication, so this impact should theoretically not materialize. Secondly, thin branches should always be left when gathering cut bush, as these help to protect young germinating grasses from being grazed, and they gradually decompose and return their nutrients to the soil. Cumulatively, loss of soil fertility may become a problem if harvesting procedures are not correctly followed, resulting in lowered rather than improved rangeland productivity. Ongoing monitoring should be carried out to keep tabs on the situation.

Bush thinning is known to lead, with certain species, to increased bush density due to vigorous regrowth. This should be monitored and the bush harvesting schedule adjusted accordingly. The cumulative impact could be a worse encroachment problem than before, especially in sicklebush-dominated areas, which would require further response such as higher frequency of harvesting and more attention to aftercare.

Increased numbers of people working in bush encroached areas is likely to lead to increased disturbance to birds and animals, such as nest abandonment by raptors and poaching of various species. The impact, multiplied many times through CBEND replication, could cause the decline of wildlife populations and loss of revenue from commercial conservancies and game and hunting farms. This is potentially significant, and very difficult to mitigate.

7.4 Positive social impacts

Employment generation through CBEND replication could benefit up to 4,800 workers, which is a significant positive impact and has a knock-on effect via the improved livelihoods of the families supported by those workers. The CBEND concept does also offer greater opportunities (than conventional farm labour) to employ women. But the benefits might not be realised to the fullest extent, due to people's reluctance to take on the demanding bush cutting work that is offered.

Training and skills improvement are additional benefits arising from CBEND employment.

7.5 Negative social impacts

Where workers live away from their families and in remote situations, social ills such as alcohol abuse and HIV/Aids and other STDs can arise. About a third of CBEND workers will be cutters in this situation, and the remainder will be employed in and around the plant, where they can be permanently housed with their families. This medium significance impact will be multiplied by as many CBEND plants that become operational, and is very difficult to mitigate. As many CBEND employees employees as possible should be encouraged to live with their spouses on farms close to the CBEND plant.

Similar to the situation in the charcoal sector, there is an increased risk of labour problems for CBEND farmers, which might create a strong disincentive for CBEND replication. This significant impact is very difficult to mitigate. The administrative procedures around the Labour Act should be strictly followed to ensure that both workers and farmers are properly protected by the law.

7.6 Positive economic impacts

Cattle production is improved by thinning of encroacher bush, and for a hypothetical encroached farm of 5,000 ha in central Namibia, thinning can add an increasing amount to the gross income from cattle farming, growing every year with the increased area that is thinned, to approximately N$500,000 after 10 years when the whole farm has had one thinning treatment. This relatively small improvement in income is greatly increased when revenue is obtained from the products of the thinning. Charcoal can generate an additional N$2.5 million, or firewood N$1.7 million, per year after 10 years. These figures show the strong economic incentive to add value to the bush. CBEND can potentially offer greater value on top of the figures quoted here, as more of the bush is utilised. However, the benefits cannot be quantified without knowledge of what infeeding price will be offered to CBEND IPPs.

The fact that CBEND activities can complement charcoal or firewood production has a positive impact on the economics. Interference with these bush utilizing industries is not expected.

A possible positive impact of CBEND in off-grid areas is the boost that electricity provision can provide for local economic activities. Income-generating activities are more readily achievable with electricity, which CBEND could potentially provide.

The CBEND concept scores positively when rated for economic efficiency, equity in the way its benefits are distributed, and intergenerational equity in the continued operations.

No negative economic impacts from CBEND replication have been identified.

7.7 Positive impacts on Namibia's electricity sector

CBEND's potentially significant positive impact on Namibia's power sector is addressed in 7.2 above, since this impact is good for both the biophysical environment and the electricity sector of the economy. In addition to the reduced need for generation by fossil fuels, replication of the CBEND concept could be achieved relatively quickly compared to the long lead times necessary for larger power stations. This would require the right market incentives and NamPower support.

A further important consideration is the technology's suitability for off-grid applications. Wood gasification power plants are available in different sizes ranging from as little as 10 kW to more than 1 MW. Small wood gasifiers, combined with a mini-grid, could thus provide electricity to unelectrified settlements, thus complementing Namibia's rural electrification programme.

7.8 Negative impacts on Namibia's electricity sector

The operation of several CBEND IPPs on a distribution network poses several challenges related to power factor considerations of the powerlines that are fed into, sensitivity of interconnections, and the possibility of generation not always being embedded. Although synchronisation with the electricity grid can be achieved through electronic equipment, the increased management and operational requirements will put pressure on NamPower and the REDs to keep the power distribution systems operating efficiently, and are likely to require more human capacity in terms of numbers of staff and skills. Thus a central coordinating agency that liaises with all different CBEND-type IPPs and coordinates the dispatch of electricity should be considered. This would imply that NamPower deals only with one single entity.

7.9 Alternative modes of bush-to-electricity generation as potential mitigatory measures

Some of the negative impacts described above may be reduced by considering the following modifications to the CBEND concept.

Separation of the two components of a CBEND operation – wood harvesting and gasifying, from electricity generation – would possibly make it easier in terms of labour management. The labour intensive part of the operation could possibly be done by wood harvesting SMEs, while electricity generation could be done separately by a more skilled workforce. In this scenario the CBEND IPP would not have to deal with the many issues around farm labour.

8 Best practice guidance and monitoring

8.1 Bush thinning guidelines

Bush thinning rather than bush clearing is the key element to harvesting for CBEND. The guidelines include the following important points:

- If CBEND is done in conjunction with production of charcoal production or other wood products, approximately one third of a 2-3 m high tree can be turned into charcoal; another third can be used for CBEND, and the remaining third of the smallest branches should be left in the veld.
- Cutting should target only encroacher species and leave behind a range of size classes of bush and trees. The number of tree equivalents per hectare after thinning should be roughly 1.5 – 2 times the average annual rainfall. Browser and protected species should not be cut.
- Manual and small-scale mechanical harvesting is best.
- No harvesting should be done on slopes steeper than 12%, and slopes from 5-12% should only be partially harvested.
- Disturbance to animals, especially nesting birds, and poaching should be prevented and penalized if it occurs.
- Aftercare is very important to limit the amount of regrowth after an area has been harvested.

8.2 Social and labour guidelines

- Training of staff and supervision of cutting activities are necessary, and should aim for improvement of the skills base of all staff.
- Staff should be employed formally in accordance with the Labour Act.
- Remuneration to cutters should be on a 'hectare-thinned' basis rather than a 'tonnage of bush cleared' basis, to create the incentive for appropriate thinning.

8.3 Technical guidelines

- Before any replication of CBEND plants, the tar waste should be tested for toxicity and whether it requires special disposal in a hazardous waste facility. If it does, safe disposal arrangements must be made.
- Early planning for a CBEND plant must ensure that there is adequate groundwater to supply the required 16 m^3 of water daily for cooling.
- The distributions grid's performance, especially in terms of the power factor, must be assessed accurately to determine the power line's suitability.

8.4 Institutional guidelines

- The increased administrative and monitoring requirement that goes with CBEND replication suggests that establishment of the proposed Namibian Woodlands Management Council should be speeded up.
- More technical staff will be required in NamPower and the relevant REDs to handle the many potential complications of grid infeeding.

8.5 Monitoring

There should be a distinction between monitoring for compliance with the regulations, and monitoring to assess the impact of harvesting to gain a better understanding of the CBEND approach.

Monitoring by various authorities should keep track of:

- The number of CBEND plants in operation and the spatial distribution of their harvesting areas
- The areas of current harvesting and the results of site inspections to detect for cutting of protected species.
- Disposal of pollutants
- Exclusion of sensitive areas and non-disturbance of protected wildlife
- Grid stability
- Compliance with the Labour Act and monitoring of number of people employed in CBEND-like operations

Impact monitoring, carried out by the NWMC in collaboration with MAWF and independent research bodies (e.g. NBRI, universities), should monitor:

- Groundwater levels close to the CBEND plants and in bush harvesting areas
- Bush densities, which will give an indication of recovery rates after thinning,
- Soil fertility and soil erosion in harvested areas.

The CBEND Trust, set up as part of the pilot project, should also be involved in monitoring these aspects at the pilot site and make the information accessible to other parties interested and affected by CBEND replication.

9 Recommendations and suggested further work

There are no further steps outlined by the National Planning Commission for CBEND replication: very much depends on the performance of the pilot project and its financial viability. Various incentives and activities could promote future replication.

9.1 Incentives for CBEND replication

Without knowing the electricity infeeding price offered to CBEND IPPs, it is impossible to judge the economic viability of CBEND. However, preliminary indications are that the CBEND concept is just on the margin of viability, and does not yet show convincing potential for entrepreneurs. It should be noted that the current economic performance of the CBEND pilot plant does not benefit from economies of scale and/or operational efficiencies. Some early lessons also indicate that some of the civil construction requirements were overspecified. The resulting expenses could be avoided on any future plants. Nevertheless, the CBEND concept will require strong incentives to become an attractive proposition for widespread replication. The onus is on the Government to create those incentives, which private sector entrepreneurs will be quick to respond to.

Incentives could include favourable interest rates and soft loans for CBEND establishment, and a grid infeeding subsidy to make the period to reach a break-even point manageable. Additionally, tax breaks and favourable conditions apply to manufacturing enterprises, for which CBEND plants could apply. CBEND establishment on communal land is currently discouraged through the lack of secure tenure on communal ground, but this could be changed if secure ownership was granted.

The Directorate of Forestry makes budgetary allocation for bush utilization projects, but apparently this has not been used yet. Also, this Directorate's programme for clearing and managing firebreaks is a potential opportunity for CBEND bush clearing.

9.2 Further studies and information distribution

Information on bush densities across Namibia's bush encroached areas is scarce. Further mapping work in bushed areas is suggested as a means to gather useful information on the total bush resource and recovery rates, to get a better understanding of the sustainable yield of bush.

Easily understandable information on encroacher and protected/valuable trees would be useful to the REDs and other organizations involved in cutting bush. This should be compiled by the Directorate of Forestry.

9.3 Policy, legislation and institutional recommendations

Two draft policies under the responsibility of MAWF should be concluded and formalized: the Strategy on Rangeland Management and the Bush Encroachment Policy. The CBEND approach could be more formally supported by MAWF with the backing of their recommendations and directives.

The requirement to do an EIA for every new CBEND proposal is seen as an obstacle to replication. We recommend that a waiver on the EIA requirement can be granted for future CBEND plants. The only significant negative impact from CBEND plants that is not well understood is the pollution potential, and this must be properly addressed in the pilot project. Once it is known, safe disposal and the other aspects of CBEND operations can be adequately addressed in each plant's Environmental Contract and EMP. The EMP must be site specific and must include aspects such as prohibiting harvesting from sensitive areas.

There are some contradictions and 'grey zones' in forestry regulations, which must be resolved. These concern mopane which is protected but heavily harvested as an encroacher, and the duration of permits granted for transport of wood.

We urge that the establishment of the Namibian Woodland Management Council would be a valuable and necessary step to facilitate replication of the CBEND concept.

10 Conclusions

The overriding concern from stakeholders was that bush encroachment is a national issue and requires a national response. The CBEND concept could make a significant contribution to solving this problem.

10.1 Most important positive impacts

CBEND's bush harvesting activity so that rangeland productivity is improved, is its most important positive impact. The improvement is significant for Namibia's resettlement farms, many of which are in bush encroached areas and would benefit greatly from improved rangeland productivity.

The features of labour generation in a CBEND-like operation are mostly positive. Compared to a charcoal producing operation, The CBEND concept carries fewer negative impacts because of the opportunity to employ permanent workers who can be accompanied by their families. Replicated 160 times, the labour generating advantage of the CBEND concept becomes significant. However, this strong positive impact is jeopardized by its potential fatal flaw described below.

Electricity generation by even ten CBEND generators will make an insignificant contribution – only 2.5 MW – to Namibia's total power needs. Only if replication sees 100 or more CBEND-like power plants operational – generating 25 MW or more – will the contribution become significant. However, important advantages of the CBEND concept are that generation is decentralised, which means that it has positive value-adding spin-offs in the community in which it is located, and long distance transmission, with the numerous environmental disadvantages that powerlines carry, is avoided.. Generation time can be adjusted to suit the demand. There is also the potential to replicate CBEND in offgrid areas.

10.2 Potential fatal flaws to CBEND replication

The good intention of creating labour intensive enterprises might be fatally flawed by the reluctance of workers to do the difficult and demanding work that bush harvesting involves. Additionally, many farmers cite labour management difficulties as the main reason for not harvesting bush for charcoal, so the labour-intensive approach of CBEND might deter farmers who would otherwise be willing to invest in it. Of course, CBEND replication is not forced to follow the labour-intensive route. Mechanized harvesting is the easiest way to avoid many of the labour issues described in this report.

NamPower, the ECB and the REDs presently appear unwilling to accommodate a replication scenario that involves many small-scale CBEND IPPs. Possibly a coordinating agency should be put in place, that would reduce their administrative burden in dealing with many small IPPs individually.

The very high capital cost of a CBEND plant is a major obstacle to replication. Added to this is the cost of the technical assessments and ensuring stability of infeeding, which may have to be carried by the IPP.

10.3 Most important negative impacts

A key constraint for the CBEND initiative is its high water demand. This will probably be addressed by finding ways to use the heat for other purposes, which removes the water constraint and increases the value-addition of a CBEND plant.

Greed / poor management / indiscriminate bush clearing may result in excessive bush removal and/or removal of valuable non-target species, including protected trees. This will require effective monitoring and law enforcement from the Directorate of Forestry.

The very toxic tar residue coming from the wood and charcoal that was used to fuel the Tsumeb smelter emphasizes the potential for similar wastes from CBEND-like plants. This must be urgently assessed.

Replication of many CBEND plants will require increased technical and administrative staff in government and its agencies, particularly Directorate of Forestry, NamPower and REDs. Establishment of the Namibian Woodlands Management Council would help to bridge part of the gap in the forestry sector.

10.4 Likely synergies

The CBEND concept complements other uses of encroacher bush such as charcoal, firewood or droppers. This synergy should be promoted in the replication of CBEND.

Coupling the CBEND technology with other small-scale activities requiring heat would not only reduce excessive water consumption, but also diversify the revenue potential.

Linking CBEND-like projects with bush clearing done for veld fire management by the Directorate of Forestry or powerline clearing by NamPower and REDs, or components of the bush utilization budget in the Directorate, will help to give greater impetus for CBEND replication.

ACRONYMS

AEA	Agricultural Employees Association
BE	bush encroachment
BOT	build-operate-transfer
CBEND	Combating Bush Encroachment for Namibia's Development
CCF	Cheetah Conservation Fund
DEA	Directorate of Environmental Affairs, MET
DNA	Designated National Authority (for the Clean Development Mechanism under the Kyoto Protocol)
DoF	Directorate of Forestry, MAWF
DRFN	Desert Research Foundation Namibia
ECB	Electricity Control Board
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
FSC	Forestry Stewardship Council
HPI	Human Poverty Index
ILO	International Labour Organization
IPP	Independent Power Producer
IPPR	Institute for Public Policy Research
IRIN	Integrated Regional Information Networks
kV	KiloVolt
kVA	KiloVolt Ampere
kW	KiloWatt
kWh	KiloWatt hour
LAC	Legal Assistance Centre
MET	Ministry of Environment and Tourism
MLR	Ministry of Lands and Resettlement
MoHSS	Ministry of Health and Social Services
MoLSW	Ministry of Labour and Social Welfare
MW	Mega watt (1 MW = 1,000 kW)
NNFU	Namibia National Farmers Union
NAB	Namibia Agronomic Board
NAU	Namibian Agricultural Union
NHIES	Namibia's Household Income and Expenditure Survey
NNFU	Namibia's National Farmers Union
NPC	National Planning Commission
NPTG	NamPower Transmission Grid
NWMC	Namibia Woodlands Management Council
OVCs	Orphans and Vulnerable children
PMU	Project Management Unit
PSC	Project Steering Committee
RED	Regional Electricity Distributor
REDD	Reduced Emmissions from Deforestation and Forest Degradation (a UN programme)
RPRP	Rural Poverty Reduction Programme (in National Planning Commission)

Acronyms (continued)

SEA	Strategic Environmental Assessment
SME	Small and Medium Enterprise
STDs	Sexually Transmitted Diseases
t	Tonne
TE	Tree equivalent
ToR	Terms of Reference

GLOSSARY

Emergency - a situation where Transmission or distribution service-providers have an unplanned loss of facilities, or another situation beyond their control, that impairs or jeopardises their ability to supply their system demand.

Emergency outage - an outage when plant has to be taken out of service so that repairs can immediately be affected to prevent further damage or loss.

Generator - a legal entity operating a licensed Generating Unit or Power Station.

Metering – Measurement of the amount of electrical energy that is produced or consumed with a meter, normally measured in kilowatt hour (kWh).

Protection - System protection deals with the protection of electrical power systems from faults through the isolation of faulted parts from the rest of the electrical network. The objective of a protection scheme is to keep the power system stable by isolating only the components that are under fault, whilst leaving as much of the network as possible still in operation.

Substation – Installation that is normally the interface between Transmission and Distribution (i.e. NamPower and the RED) where voltage levels are lowered (say from 66kV to 33kV) through transformers and various other installations required for metering, operation and safety.

Transformer - A transformer is a device that transfers electrical energy from one circuit to another through inductively coupled conductors i.e. the transformer's coils. A transformer is used to step voltage up or down, for example it steps up from 400V to 33kV.

Tree equivalent – a 1.5 m high tree is one tree equivalent. A tree of 3 m is two tree equivalents, while three trees of roughly 1 m height each is also two tree equivalents.

Wheeling charges - a levy that the Generator will have to pay to NamPower for making use of the NamPower Transmission Grid (NPTG) to transfer electricity from the point of generation to a dedicated customer at another location on the grid (i.e. NamPower acts as a “middle man”).

TEAM and ACKNOWLEDGEMENTS

The CBEND SEA team comprised the following:

Peter Tarr	Project director
John Pallett	report compilation and team leader
Colin Christian	environmental impacts and bush harvesting
Cronje Loftie-Eaton	technical issues around powerlines and electricity
Wallie Roux	economics
Jacquie Tarr	social aspects
Katharine Dierkes	mapping
Gudrun Denker	office administration
Robyn Christians	assistant

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SUGGESTED CITATION

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1 SCOPE OF THE STRATEGIC ENVIRONMENTAL ASSESSMENT

1.1 Introduction to the CBEND Project and the intended replication programme

The Desert Research Foundation of Namibia (DRFN) is implementing a project entitled "Combating Bush Encroachment for Namibia's Development (CBEND)." The project is funded by the European Union through a grant from the National Planning Commission's Rural Poverty Reduction Programme (RPRP).

CBEND is a proof-of-concept project which will procure and install one 0.25 MW bush-to-electricity power generating plant in a densely bush encroached area of rural Namibia. Fuel for the power plant will be derived from harvested invader bush. The electricity produced, using wood gasification technology, will be supplied to the national grid.

It is hoped that the CBEND concept will be replicated more widely if it is shown to be viable by the Project currently underway. This pilot project does not have a formalised roll-out procedure for replication; rather, market forces and entrepreneurship will drive the intended replication. The potential expansion could lead to:

- enhanced efficiency of bush harvesting,
- rangeland rehabilitation and increased livestock production in the agricultural sector,
- development of small and medium harvesting enterprises, and
- the establishment of commercially operated small Independent Power Producers.

With the amount of bush encroached land and considering the maximum distance from appropriate powerlines, it has been estimated that Namibia has approximately 60 MW generation potential using small decentralised bush-to-electricity power plants (Emcon 2007). Thus, 120 to 300 power plants could be established on communal and commercial farm lands in Namibia, considering that the individual sizes of these plants range between 200 to 500 kW.

Using this approach, CBEND aims to address three issues of primary concern in rural Namibia:

- the prevalence of bush encroachment,
- the high unemployment rate,
- insecurity and instability of the national electricity grid by supplementing generation capacity with an indigenous, sustainable, renewable fuel source.

1.2 Summary of the Terms of Reference for the SEA

The SEA is to assess the impacts of replication of the CBEND model. The objectives of this SEA include conducting sustainability appraisal, environmental appraisal, sectoral assessments and socio-economic appraisal. The study will provide the project implementing partners and decision-makers in Namibia with relevant information to assess the environmental challenges and considerations that may impact on the environment, policy, socio-economic, political and cultural set up of communities in which projects of such nature would be implemented. This information shall be pivotal in ensuring that any concerns are appropriately integrated in decision-making and future implementation processes.

Specifically this SEA shall:

- Briefly describe alternatives to the CBEND concept in terms of bush utilisation and power generation;

- Predict the aggregate and cumulative effects (both positive and negative) of large-scale replication of the CBEND concept;
- Identify the significance and magnitude of biophysical and socio-economic impacts based on the typical, rather than specific, features of the CBEND concept on local, regional, trans-boundary and global levels;
- Assess any possible risks associated with a large-scale replication of the CBEND concept on local, regional, trans-boundary and global levels;
- Identify suitable and feasible mitigation measures to avoid and/or reduce adverse environmental consequences;
- Determine, through stakeholder consultation and participatory processes, the sentiments and concerns of national key stakeholders and interested and affected parties;
- Summarise the institutional and financial implications of possible programmatic and policy interventions by the Namibian government to support bush-to-electricity initiatives.

1.3 Outputs agreed to in the Inception Report

The findings of the assessment will be compiled in a Report. The salient findings will be compiled into a non-technical Summary. In addition, an easy-to-use Monitoring Handbook will be prepared and submitted to the client, for dissemination to stakeholders.

The Inception Briefing Meeting agreed that point 4.4 of the ToR, “Identify alternatives to the CBEND project” will be briefly addressed, and that point 4.12 “Evaluate alternatives, taking account of environmental, social and economic considerations and make recommendations” will be omitted. This is because the focus of this SEA should be kept on the CBEND concept rather than on making comparisons with other methods of using bush, and because a quantitative comparison of alternatives can be misleading. Furthermore, the Honsbein & Joubert (2009) draft report provides an economic comparison of bush-related industries, which will be documented/referenced in the SEA report.

The meeting agreed that the focus of the SEA should be kept on CBEND and its replication, to prevent the assessment getting involved in the lengthy debate on environmental, social and economic issues affecting the entire bush encroachment sector in Namibia.

All the other specifications from the Terms of Reference remain unchanged.

2 BACKGROUND

2.1 Justification: the need for an SEA and SEA as a tool

Impact assessment in Namibia, as in most African countries, is focused mostly at the project level. At this level, indirect impacts are often ignored and potential cumulative impacts are difficult to evaluate.

By contrast, Strategic Environmental Assessment (SEA) is the application of impact assessment to policies, plans, and programmes. In the case of CBEND, the post-pilot roll-out will likely be a series of bush-to-electricity projects that constitute replication of the CBEND concept.

There are many different approaches to SEA. One is the Environmental Impact Assessment (EIA) model where the impact assessment is carried out on a policy, plan or programme once it has already been developed (i.e. reactive). Another is an integrated and/or ‘sustainability led’ approach that strives to meet sustainable development objectives. This is more proactive because the results of the SEA can be integrated into policy and planning processes. Importantly, SEA encourages an ‘opportunities and constraints’ type approach to development, where such things as natural resources and ecosystem services at landscape scale define the ‘framework’ within which development can take place, the types of development that could be sustained, and the best ways that subsequent projects should be planned and implemented. The CBEND SEA follows a proactive approach as the programme is not yet defined and the pilot phase has also not yet been concluded.

The main advantages of SEA include:

- Its potential to address cumulative impacts;
- Its ability to provide ‘big picture’ frameworks within which a variety of projects can be assessed; and
- Its potential to inform land use planning in such a way that important environmental issues are ‘red flagged’ as early as possible at a strategic level.

The main drawback is that the assessment is, by necessity, ‘broad-brush’ and at the strategic level. Focus must be maintained on those specific aspects of a project that translate to significant impacts when they combine with others cumulatively.

The conducting of an SEA does not rule out subsequent project-level EIAs. For example, future CBEND projects may still need an EIA to address site-specific issues, and an Environmental Management Plan (EMP) to guide implementation within the ‘ring fence’. Alternatively, it may be decided that the SEA provides sufficient overall guidance and that an EIA is not needed. Either way, a comprehensive, outcomes-based EMP will always be needed so that there are clear procedures that prevent the occurrence of negative impacts.

The decision to require an EIA or not rests with the Directorate of Environmental Affairs (DEA) in the Ministry of Environment and Tourism (MET), and the norm in this regard is that each case is handled on merit. In principle, if a CBEND project is to be located in an environment that is not particularly sensitive (a typical bush encroached farm), an EIA will likely not be needed. However, if the farm/area supports many sensitive species (e.g. protected trees) or habitats (e.g. wetlands or archaeological sites), then a site-specific EIA will probably be required (see Section 9.3.2).

While the Environmental Management Act and Electricity Control Board regulations stipulate the need for an EIA for CBEND, this SEA goes beyond the requirements of the law. The

National Planning Commission can be commended for seeking to understand the consequences and implications of wider replication of the CBEND concept.

The distinction must be made between the CBEND pilot plant that is operating on farm Pierre, and the replication of CBEND-like plants and the CBEND concept that is the focus of this SEA. Where there may be confusion, we use the term CBEND-like plants or the CBEND concept to describe the plants that may be replicated in future.

2.2 SEA approach and methodology

2.2.1 Literature research

Bush encroachment has been the focus of much attention and concern, but relative to this level of concern there is a sparsity of accurate, hard information. The SEA used the following written sources for most of its information needs pertaining to bush encroachment per se:

- De Klerk, J.N. (2004) *Bush Encroachment in Namibia*.
- Leinonen, A. (2007) *Bush encroachment – the challenging resource for the renewable bioenergy in Namibia*.
- Honsbein, D. and Joubert, D. (2009) *Incentive Scheme for Invader Bush Management – A Cost Benefit Analysis. June 2009*.

Other literature on fields affecting or affected by the CBEND concept included:

- Social information (population, distribution, employment, health, conditions on resettlement farms) derived from national reports and research papers.
- Biophysical information, derived from general sources (e.g. Mendelsohn *et al.* 2002 Atlas of Namibia, Barnard 2001 Biological diversity of Namibia) and specific reports addressing use of bush (e.g. Ohorongo Cement EIA, CCF Bushblok EIA). Research into the geohydrological impacts of bush encroachment has produced only draft reports (e.g. Bockmühl 2008), but in the absence of other finalized information in the public domain, these were used.
- Economic and financial information around the CBEND pilot project and bush utilization.

An accurate list of government-owned resettlement farms, with numbers of people on the farms, is not available from the Ministry of Land and Resettlement. Different versions of what is most accurate exist with this ministry, NAU and private researchers. Due to time constraints we did not spend effort resolving this confusion (that would take dedicated effort over many months), and the report and data of Mendelsohn (2008) was used.

A 2010 Labour report quoted in Die Republikein newspaper, giving information on the level of unemployment and need for employment generation, was not provided by the Ministry of Labour despite repeated requests from NPC and the SEA team.

Although about 200-300 farms in Namibia are harvesting wood for charcoal production, and a Charcoal Producers Association is part of the NAU, we could not access a list of the farms or the location of farms where harvesting for this purpose occurs. The Directorate of Forestry issues permits for wood gathering for any commercial purpose, and we were advised to derive this information from the register of permits. This has been done as far as possible, but non-response from certain DoF offices renders the list still incomplete.

2.2.2 Field research

The broad-brush, strategic nature of the SEA ruled out any primary field research. Familiarisation with the area and the concerns of local farmers who are potential interested and affected parties was done during a field trip to the Otjiwarongo, Otavi and Grootfontein areas, coinciding with the site visit for tenderers to the CBEND site on farm Pierre, in mid-January 2010.

2.2.3 Expert opinions and stakeholder engagement

Opinions were sought during the above-mentioned fieldwork and with various experts based in Windhoek. Discussions were held with officials in NamPower, ECB, Directorate of Forestry (MAWF) and Directorate of Resettlement (MLR).

Discussions with stakeholders were divided into five 'mini' themes to encourage interested and affected parties to participate in short, manageable sessions rather than a long workshop. Despite invitations and ample forewarning about the themed discussions, there was no participation or involvement in these discussions from MET, MLR or MoF, which are key institutions in CBEND replication. This will make future replication more difficult since the discussions allowed stakeholders to share information and learn about what is intended. However, their absence does not jeopardise the viability of replication, it only slows it down and makes the process frustrating.

A list of stakeholders consulted during the SEA is provided in **Appendix A**.

2.2.4 Limitations of the SEA

The CBEND power plant is not yet installed, and power generation using encroacher bush has not yet been proven in Namibia. Research by DRFN to assess feasibility and practicalities shows that the technology has proven itself in other parts of the world and it is likely to work as effectively here in Namibia. Nevertheless, the CBEND pilot project has not yet reached a point where it can inform the intended roll-out scenario. In this sense, the SEA cannot inform stakeholders on feasibility and practicalities.

Due to this situation, the intended replication is not a 'programme' and it is unclear what level of replication can be expected. The options vary from no further CBEND-like plants at all, to 160 plants (see Section 7.1). The replication depends greatly on the findings of the pilot project and, most critically, whether the economics of the project make it look attractive for interested entrepreneurs.

The shortcomings in the literature and ministry information (see 2.2.1, 2.2.3) make it difficult to project the roll-out potential. For instance, the only available map of bush encroachment in Namibia originates from work done in the 1980s and 1990s and has very coarse resolution. It can be very misleading to use what appears to be accurate and well-founded information, when the situation on the ground is possibly very different.

The SEA was hampered by difficulties in securing an economist. The person identified for the team in SAIEA's proposal left the country unexpectedly before the work began, and interim specialists were unable to give the project the required priority, until a dedicated economist was found. This delayed completion of the work but did not compromise the final product.

3 PROGRAMME DESCRIPTION

3.1 Objectives of the CBEND Project

The CBEND Project aims to address three issues of primary concern in rural Namibia (NPCS 2006):

- the prevalence of invader bush,
- the country's energy deficit and insecurity of supply
- the high unemployment rate amongst primarily young Namibians.

Central to this project is the notion that woody biomass actually represents an economic opportunity. The project focuses on the conversion of invader bush to electricity using wood gasification technology. The technology has been refined in recent years and is ideally suited for small to medium-scale electricity production (i.e. less than 5 MW). The process of wood gasification requires a large amount of wood to be harvested daily, which in turn requires a large workforce. This creates an excellent opportunity for small and medium enterprises in rural areas to harvest invader bush and generate electricity to feed into the national grid.

The primary function of CBEND is to demonstrate the viability for environmentally sound bush reduction (i.e. improved rangeland) and economically viable electricity generation using wood gasification technology. The project will sensitise policy makers about the benefit of providing a conducive environment for industries using invader bush in Namibia.

3.2 CBEND Project methodologies

The direct beneficiaries of the CBEND Project will be chosen from emerging commercial farmers of Namibia's Land Reform Process. The harvesting and production activities will ideally take place on one or more resettlement farms, depending on criteria such as bush density, access to the national electricity grid and the ability and willingness of farmers to participate. Wood harvesting teams will be established, which will provide direct employment for either those on resettlement farms or in the vicinity.

1. A Project Management Unit (PMU) has been established for overall project implementation and management, and is guided by a Project Steering Committee (PSC). The Project has established a Trust which will become the long-term owners of the gasification equipment. The Trust will ensure that the equipment is used for its intended purpose by leasing it to an Independent Power Producer (IPP) on specific terms. The revenue generated from leasing the equipment will be managed and utilised by the Trust to replace equipment over the long-term and fund awareness raising campaigns. A strong and effective Trust is necessary to manage the plant through the IPP.

This project involves the establishment of Namibia's first IPP, and fulfilling the necessary requirements for its registration. Regulations governing the establishment of an IPP are being reviewed in detail with the ECB, with the view to reducing barriers to establishment of other IPPs in future.

The IPP was selected and appointed on a public tender basis, and will operate the bush-to-electricity plant on a build-operate-transfer (BOT) principle. The IPP will follow a business plan that has been compiled for the Project.

2. The PMU has identified a suitable farm on which to erect the plant, namely farm Pierre owned by Willem Groenewald in the Outjo District. The Queen Sofia Resettlement Project farm is located about 10 km from the plant site. Pierre was selected since the nearby

resettlement farm is bush encroached and people who could be potential CBEND staff live there.

A wood harvesting permit will be secured to comply with the regulations of the Directorate of Forestry. In the event that bush harvesting regulations might not be readily applicable and/or implementable under a resettlement farm scheme, recommendations for amending elements of this regulation will be submitted to the Directorate of Forestry.

Regulatory requirements of the ECB and NamPower, with regard to a Power Purchasing Agreement, will be met through the Project.

3. The PMU has procured the gasification technology and is overseeing its installation. All equipment and tools necessary for the operations of the IPP, such as harvesting equipment, will be procured by the project.

4. Comprehensive training will be developed for and provided to the IPP by the supplier and the PMU. The Project also intends to deliver training to farmers involved in the project regarding the operations of the bush-to-electricity IPP, the control of invader bush, sustainable rangeland management practices, long-term aftercare and management of invader bush, and on environmental monitoring procedures. This will help ensure that the rehabilitated rangeland is better cared for over the long term, and that environmental and socio-economic benefits are sustained.

5. Operational procedures for the power plant will be established. For instance, employment contracts for harvesters will be drafted, which will form the basis for outsourcing harvesting to independent SMEs in future. Work programmes will be defined to ensure optimal land clearing (including aftercare), delivery and drying of wood and reliable electricity generation and supply. In terms of the latter the financially most optimal time of supply will be set. This will potentially allow the IPP to benefit from higher revenues when supplying during peak periods.

6. The PMU will monitor the performance of the IPP contractor. The key element to establishing the financial viability of bush-to-electricity will be the assessment of the income generated and the expenses incurred by the IPP. An economic feasibility assessment will be conducted, based on data from the Project. The information gathered and lessons learnt will form the basis for replicating the bush-to-electricity concept on commercial principles.

The PMU will also monitor the socio-economic impacts of the project activities, such as the impacts on the livelihoods of the harvesting teams and the impacts on the farmers whose rangeland has been cleared.

7. Recommendations will be made to amend existing policies or to create incentives for expanding bush-to-electricity initiatives.

8. Lessons learnt will be condensed into a user-friendly hand book for prospective small-scale IPPs. The purpose is to open the IPP playing field to investors and operators, and to make key decision-makers in Government and the energy sector aware of the benefits of bush-to-electricity projects, in the hope of increasing incentives for ‘green power’ projects.

Awareness of the potential will also be raised amongst farmers and SMEs (as prospective service providers). This will include information on the economic potential of bush-to-electricity, for comparison with other bush eradication activities, such as poisoning and burning.

After completion of the project, all further monitoring activities will be conducted by the Trust in partnership with relevant institutions.

3.3 Expected outcomes of the CBEND Project and anticipated replication

The CBEND Project expects to establish an operational framework for bush harvesting and electricity generation. At the same time, policies will be amended or created to make incentives for expanding bush-to-electricity initiatives. The economic feasibility assessment will help to inform the replication of bush-to-electricity projects on a commercial basis.

If the CBEND concept is proven to be financially feasible and attractive, then it is hoped that other farmers will replicate the model on a wide scale. The expanded programme is expected to lead to four main outcomes:

- Enhanced efficiency of bush harvesting;
- Increased livestock production in the agricultural sector;
- Development of small and medium harvesting enterprises; and
- Establishment of commercially operated small IPPs.

3.4 Specifications of a typical CBEND power plant

The following specifications will be used as the template on which to assess impacts and viability of the CBEND concept. These figures are based on a 250 kW plant; fuel and waste production can be scaled up proportionally for plants up to 1 MW.

Table 3.1 Specifications of a typical CBEND plant

Criterion	Specification
Maximum distance to power line	500 m
Capacity of power line to feed in to	11 / 22 / 33 kV
Typical producer gas composition	N_2 – 50% CO – 19±3% H_2 – 18±2% CO_2 – 10±3% CH_4 –Up to 3%
Generation capacity	250 kW
Fuel requirement	1,550 t wood/a = 6.5 t wood/day
Water requirement for evaporative cooling	16,000 l/day
Area of harvesting over 1 year, at take-off = 2 t/ha	780 ha
'Exclusive area' for harvesting around power plant, for ~ 50% bush clearing over 10 years (excludes re-growth and/or aftercare)	4,000 ha
Solid waste production	800 kg tar-contaminated sawdust every 20 days. Fed back into gasifier.
Ash and biochar production	Ash – 300 kg/day Char – 200 kg/day
Tar sludge production	500 l/day Can be used (like creosote) on the farm for preserving wood
Brine waste product (from water softening, if applicable)	300 l/day
Capital cost of gasifier and establishment of plant (2010 prices) and wood processing and handling equipment	N$ 9 million
Expected life of plant (with regular replacement of wear and tear components)	20 years

3.4.1 Employment opportunities through CBEND

A typical CBEND project will require between 25-30 staff, combining manual and mechanical methods to cut and transport bush, and to operate the plant (Table 3.2) However, if CBEND activities are done in conjunction with charcoal or dropper production, then bush cutters will not be needed and fewer labourers will be required.

Table 3.2 . Labour requirement for a CBEND power plant (not linked to a charcoal operation) (pers. comm. Schultz 2010)

Labour class	**8 hour shift (morning)**	**8 hour shift (afternoon - evening)**	**Total**
Plant Manager (skilled)			1
Foremen (semi-skilled)	2	2	4
Plant operators (labourers)	4	4	8
Bush gatherers (labourers)	4	0	4
Bush cutters (labourers)	8	0	8
Tractor driver (semi-skilled)	1	0	1
Total			26

Plate 3.1: Harvesting machinery acquired for the CBEND operation (left), and construction of the plant at farm Pierre. Photos by DRFN.

THE NAMIBIAN — ENVIRONMENT

Paving the way for green energy

• JANA-MARI SMITH

The first "green energy" kilowatt-hours to be fed into Namibia's national grid could herald the start of a two-pronged solution to Namibia's invader bush and electricity supply issues.

The project, which addresses electricity security and bush encroachment, is funded by the European Commission and is being implemented by the Desert Research Foundation of Namibia.

A 250 kW gasification plant will convert invader bush – acknowledged as an environmental problem in Namibia – into electricity via a wood-gasification process, and has the ability to supply electricity to about 200 middle-income houses.

Robert Schultz, co-ordinator of the project Combating Bush Encroachment for Namibia's Development (CBEND), said this week that it is still a "proof of concept project" and the aim is to convince Namibians and Government of its feasibility.

Schultz is confident about the technology, saying it "is robust, maintenance friendly and simple to operate", although it is only marginally financially feasible under current market conditions in the form of cheap electricity imports from Eskom.

He said that wood gasification could add "a new dimension" to the agricultural sector – by giving farmers an opportunity to utilise available resources on their land and to diversify their revenue potential.

While fuel for the plant will be derived from invader bush, the emphasis is on bush thinning and not on complete bush clearance.

Schultz and a technical team, including Namibia's first "green" farmer, Willem Groenewald, who will operate and manage the plant as an Independent Power Producer, returned from a trip to India at the end of January.

The plant will be located on Groenewald's farm about 70 km north of Otjiwarongo.

The team visited Ankur Scientific Technologies, which has a 30-year track record in this type of technology, and from whom the 250 kW plant will be bought.

The company produces and sells as many as 100 units of varying sizes a year to developing and developed countries that are keen to clean up their energy acts and enter green energy markets.

The plants can be modified to convert most types of biomass, including wood, coconut shells and rice husks.

Schultz said they will start assembling the plant in April, with production scheduled for June.

He hopes the plant will become a blueprint for the production of green energy in Namibia. The "purpose ... is to prove that this project is feasible; financially, technically and operationally", he said.

The DRFN embarked on the project two years ago with financial support from the European Commission and in partnership with the Namibia Agricultural Union and Namibia National Farmers Union.

Although CBEND hopes to bring NamPower on board as the main client, another option is to sell the "green energy" to large power users in industry, who want to reduce their carbon footprint.

South Africa encourages green energy producing projects similar to the gasification project by paying producers "grid in-feeding tariffs", as an incentive for more local 'green' electricity generation.

A plant uses approximately 400 hectares of bush a year, if only half of the bush is removed per hectare.

Namibia could support 200 CBEND-type power plants, which could thin out more than 100 000 hectares of invader bush per year – out of an available 26 million hectares.

TURNING PROBLEMS INTO SOLUTIONS ... Dr Detlof von Oertzen, technical advisor to the CBEND Project, inspecting the feeding hatch of the gasifier at the Ankur Scientific factory in India.

Figure 3.1: Article published in The Namibian on Tuesday 11 February 2010, describing features of the CBEND project and its intended outcomes.

4 PROGRAMME ALTERNATIVES

4.1 Alternatives uses of encroacher bush

The cost-benefit analysis of uses of encroacher bush conducted by Honsbein and Joubert (2009) shows that the production of charcoal and small-scale gasification for electricity generation (CBEND) has the most promise for turning Namibia's national wood resources into higher value products that can involve broad economic participation and technology transfer. Nevertheless, for the purposes of this SEA it is valuable to briefly consider the alternatives that could address the bush encroachment challenge in Namibia, as they may influence the extent of replication of the CBEND concept.

4.1.1 Charcoal production

4.1.1.1 Traditional small scale charcoal production

Approximately five tonnes of wood are needed to produce 1 tonne of charcoal (pers. comm. Galloway 2010). This amount varies depending on the quality of the bush: estimates from farmers vary from 3.5 to 7 tonnes, and depend on factors such as the tree species, amount of moisture in the wood, and skill of the charcoal burner. The charcoal industry in Namibia was worth N$ 75–100 million (in 2004) and continues to grow (NAU 2010, Mendelsohn 2006), with 200-300 farming operations involved in this activity (Enslin 2010, pers. comm.). There are differing reports on the amounts of charcoal produced in Namibia - from 50,000 t/year (pers. comm. Galloway 2010) to 90,000 t/year (Honsbein and Joubert, 2009). Harvesting for charcoal was originally to supply the smelter at Tsumeb which was partly fuelled by charcoal. Now the main market is South Africa and overseas, but this is claimed to be volatile as it is mainly for the leisure industry (pers. comm. Galloway 2010). Currently there is a large demand for charcoal from silicon smelters in South Africa, and this industrial market is more stable. Farmers interviewed stated that charcoal has proven itself as a profitable and sustainable industry, but has unique labour-related challenges.

The conditions of Namibia's charcoal workers are discussed in the baseline socio-economic chapter (5.2). In most cases the charcoal makers are contracted by the commercial farmer and are not full-time employees. Despite the potentially good income from bush cutting, it is extremely taxing work and it is not easy to find committed bush cutters.

Charcoal production is done using simple kilns, which are easy to operate and appropriate to the local farm conditions. Honsbein and Joubert (2009) state that while charcoal production from bush kilns can be economically viable, the environmental consequences are significant, yet there are no emissions controls or safety procedures for their use. Over 80 wt% of the input dry wood to the bush kiln is emitted as tars, smoke and non-condensable gases (including CO, CO_2, CH_4 and H_2), some of which can be damaging to workers and the environment.

Another problem is the fact that the bush cutters, obviously, are focussed on making as much profit from their bush clearing efforts as possible. As they are paid per tonne of bush cleared or per tonne of charcoal produced, indiscriminate harvesting of wood – including big trees and non-invasive species – is alleged to occur. Strict enforcement of forest-friendly harvesting principles, as laid down by the FSC and Honsbein and Joubert (2009), is necessary to prevent this.

Farmers interviewed during the course of this project were of the opinion that there is adequate bush to sustain expanding charcoal production, and there is no sign that reduction of bush will hinder production.

While the above environmental and social issues around charcoal production are noted, this assessment cannot pronounce on whether the problems require significant mitigatory measures or the scope of such measures. The point is that charcoal production is an accepted means of debushing and will influence the decision of a farmer looking for profitable ways to combat encroacher bush.

Plate 4.1: Charcoal production using a simple kiln, and examples of the end product. Note the fine branches left as being too thin for charcoal.

4.1.1.2 Charcoal from advanced kiln technology (commercial charcoal production)

During commercial, advanced kiln charcoal production, the controlled combustion of wood generates heat to initiate pyrolysis. In some cases, the gases are cooled and liquids are condensed. The residual gases may be burnt to heat the process, dry the fuel or be available for other uses (space heating, power generation).

The total cost of producing charcoal this way (depending on what equipment is used) is much higher than the price paid by wholesalers in Namibia for charcoal. Thus there is currently limited scope for this method of charcoal production in Namibia.

4.1.1.3 Biochar for use as a soil supplement

Charcoal produced under controlled conditions as a soil supplement or ‘biochar’ is another alternative that can be considered as a means to turn bush into profit. The use of this product in soils has been shown to have positive benefits in terms of water holding capacity and plant growth. Honsbein and Joubert (2009) report that there is insufficient information at this time to assess the value of char from encroachment bush in Namibia, but that it is an area of research that is worth pursuing, given the poor status of most Namibian soils and the likelihood that biochar can enhance crop yields. There is uncertainty about the organic value of biochar which is produced under very high temperatures, as CBEND biochar will be (pers. comm. Lenhart 2010). This is being investigated by the NAB.

4.1.2 Bush for firewood

Wood sold for domestic cooking fuel can be an economic alternative for farmers who want to clear bush on a large scale. In rural areas, the price of firewood ranges from N$ 150 to N$ 400/t, while the firewood price in Windhoek ranges from N$ 400 to N$ 600/t. Firewood exported to South Africa and the market in the European Union fetch much higher prices (Honsbein and Joubert 2009). While harvesting firewood can target encroacher species such as mopane, sicklebush and purple terminalia, non-encroachers (e.g. camelthorn) are often sold locally for the leisure market. Harvesting of the latter can therefore not be considered as a method to combat bush encroachment; nevertheless, harvesting of the encroacher species for this sector of the market is significant.

The Directorate of Forestry revealed that in 2000/2001 (the most recent data) 58,000 t of wood were harvested for wood fuel, of this 33,000 t were marketed – the rest was used predominantly by poor people for cooking and heating. Of the marketed wood about 2,000 t were exported. The data does not reveal whether this was from bush encroacher species.

4.1.3 Fluid bed fast pyrolysis (producing 0.25-13 MW)

In this process a liquid fuel is created - suitable for bottling and transportation, or for use onsite for power generation at localities that are far from the grid. Some pyrolysis liquids can also have non-energy uses. They can be used to produce fertilisers, biolime, resins and other speciality chemicals. The feedstock is delivered as chips or sawdust and the cost of processing the chipped bush to fine particles needs to be accounted for when assessing the economic viability of this alternative.

The electricity production cost from fluid bed combustion of encroachment bush is higher than commercial consumer cost (Honsbein and Joubert 2009). Furthermore fast pyrolysis plants are complex to run and maintain and the risks associated with the technology are high. The use of diesel as the dual fuel adds a significant cost to the process and, because of these constraints, the use of fast pyrolysis for the production of electricity in Namibia is not viable at present.


Plate 4.2: Mopane wood being sold locally as firewood for the recreational braaing market (left), and silver terminalia branches cut and trimmed as droppers.

4.1.4 Other products from encroachment bush

Other opportunities for the use of encroachment bush include:

- Extruded wood logs (‘Bushbloks’). This is carried out by Cheetah Conservation Fund, and the operation covers a relatively small area (few hundred hectares) to feed a factory in Otjiwarongo. The main objective is to thin encroacher bush on the farm to enhance the habitat for cheetah. The enterprise recognises that the market for Bushbloks is quite small but is satisfied that, for its purposes, it is viable and sustainable.
- Pelletizing, as a co-combustion fuel for electricity generation. This uses more wood out of a total tree than charcoal or CBEND, and is hoped (by the one farmer promoting it strongly) to supply a large overseas market since Namibian bush has superior calorific content. Most other stakeholders consider this activity, targeting the European market, to be not viable.

- Poles and droppers. This is a very small market. Some farmers, in the process of charcoal harvesting, select long thin poles (especially from mopane and silver terminalia), treat them against insect attack, and sell to small, local markets.
- Wood chip briquettes
- Composite wood-cement boards
- Composite wood products (e.g. chipboard, doors, coffins)
- Animal feed.

While some of these initiatives are successful and ongoing (e.g. Bushbloks, poles and droppers), others have limited potential or have failed financially in Namibia.

4.1.5 CBEND done in conjunction with charcoal production and/or other small industries

Charcoal production, firewood harvesting and other small industries (e.g. the manufacture of fence droppers) can be done in conjunction with the CBEND concept for enhanced value adding. In this way very little wood will be wasted - especially the 'fines' which can be used for feeding into CBEND plants (up to 20% of the total fuel). One farmer (W.Enslin, past Chairperson of the Charcoal Producer's Association) gave the rough guideline that one third of a large tree can be turned into charcoal; another third can be used for CBEND, and the remaining third of the smallest branches should be left in the veld. This synergy also offers the benefit that the farmer already has systems in place for management of labour, which can relatively easily be extended to a CBEND operation. A CBEND operation was viewed by some stakeholders consulted as the 'perfect compliment' to charcoal production.

The only constraint in this scenario is that CBEND sites need to be located at or near the farms where bush clearing occurs to minimize transport costs. A CBEND plant could be used to provide off grid electricity to the farm and surrounding areas, or if it is going to generate power for the national grid, would need to be near existing appropriate-sized powerlines.

With respect to 'fines': charcoal and firewood use the largest pieces of wood in a tree, and CBEND can use the smaller material. With or without harvesting for CBEND, there should be some thins purposefully left behind. They provide a micro-environment which protects emerging new grasses, and over time they rot and return nutrients to the soil.

4.2 Alternative methods of clearing encroacher bush

Various methods for bush clearing are in practice, such as manual cutting, mechanical clearing (using bulldozers or dedicated bush-cutting machinery), use of arboricides (selectively or by aerial spraying), burning and biological control.

4.2.1 Chopping by hand

Hand labour, if well supervised, can be highly selective, targeting problematic bushes and trees and leaving grass and desirable plants, to create optimum 'savanna-like' rangeland. Chopping by hand has almost no negative environmental impacts, the only one being that if it is not closely supervised, the wrong trees or bushes – such as protected species or kinds which are valuable browser species – may be cut down. This is physically very strenuous and demanding work, and supervision and management of cutting teams takes up a large proportion of the total bush-clearing effort.

4.2.2 Mechanical clearing

Mechanical clearing involves much less management, but is more expensive. Bulldozer-like machinery is generally damaging to the soil, which brings weeds and vigorous regrowth of bush afterwards, and tends to waste a lot of bush. Smaller-scale machinery such as a cutter-head on an excavator machine can be very selective and, operated properly, needs inflict no damage to the soil. The large-scale bush clearing machinery proposed to clear bush for fueling the Ohorongo cement factory is selective and efficient, yet very capital intensive. The cost of such machinery makes this option uneconomical for bush thinning at the CBEND scale.


Plate 4.3: Cutting by hand or with a small mechanized cutter head is the best method to produce the desired level of bush thinning (left). Bulldozers are much less selective and cause vigorous regrowth afterwards.

4.2.3 Application of arboricides

Arboricides are widely used and are sold at cost to farmers by the Meat Board. Of particular concern is the aerial application of arboricides, which kills all woody plants including protected species and those trees which are beneficial to rangeland health. Although dosage rates during aerial application are supposed to be set conservatively, some species of trees (e.g. African Chestnut *Sterculia africana*) are much more sensitive to arboricides than others, so that these desirable trees are unintentionally killed even though they do not encroach and are protected by law. Application by hand is more selective, but can also kill desirable trees that have very extensive lateral root systems. Although these arboricides are reputed to be non-toxic to fauna and birds, the use of chemicals always poses the risk of unforeseen negative impacts (Honsbein and Joubert 2009).

Many farmers use arboricides and there is a concern that trace remnants of the poisons might be detected in beef for the export market, thus jeopardizing this very valuable trade. Export meat quality inspections locally and by the EU authorities have not yet detected any sign of arboricide-related toxic chemicals in Namibian beef, so the use of these chemicals is presumed to be safe. Additionally, the Meat Board promotes the use of arboricides by selling it at cost price, and it is presumably not in their interest to jeopardize the beef export market. Nevertheless, there is an urgent need to thoroughly investigate the toxicity of the arboricides and their breakdown products, with ongoing monitoring to be vigilant for long-term effects that might not be detected at first.

4.2.4 Fire and biological control

Burning is not widely practiced simply because the lack of grass fuel in encroached areas makes it ineffective. In some cases it can work, but it is viewed by many farmers as risky as the fire can get out of control.

Introduction of a fungus to kill encroacher bush has had very limited success.

4.2.5 Summary of bush harvesting alternatives most applicable for CBEND

For CBEND, it is preferable that bush should not be killed before it is harvested, as this makes the wood hard and more difficult to cut. This rules out all but manual and mechanical methods as being most appropriate for the CBEND concept. These two methods (but not including bulldozer-style mechanized clearing) are also best suited to thinning rather than clearing of bush, which fits the aim of restoring rangelands to a savanna-like condition. While it is easier to manually harvest wood that is still green, the chipper and the gasifier both require that the wood is dry (<20% moisture).

The importance of aftercare is emphasized in the literature and the draft Policy on Bush Encroachment. Various methods are in use to manage the regrowth of bush following harvesting. These include hand application of arboricides, stem burning, and intensive browsing by goats or antelope. The judicious use of fire can also be considered as a preventative rather than a curative measure to prevent young seedlings getting established.

4.3 Power generation alternatives

The CBEND concept represents a limited opportunity for power generation (0,25 - 1 MW) but because this power can be produced in remote locations (provided they are less than 500 m from a suitable powerline) it has high potential in Namibia's rural areas. Namibia's power generation challenge is presented below together with the supply alternatives currently available.

4.3.1 Namibia's power generation challenge

Namibia's Energy White Paper states that 100% of peak demand should be met, and that at least 75% of total electricity requirements should be derived from internal sources by 2010 (extended to 2012 in NDP3). Power demand in the country is projected at a 'natural' growth of approximately 4.5% but the demand from new sources such as uranium mining and its associated desalination and other industries could result in a 50% step up in demand in the next 10 years.

At present approximately half of Namibia's electricity is supplied from Ruacana Hydropower project on the Kunene River, while most of the balance is imported from South Africa or the Southern African Power Pool. Due to the growth in internal demand in South Africa the surplus, which has for years been distributed to neighbouring states, is likely to be reduced. Thus Namibia must urgently increase internal generation capacity.

Over the past seven years or more, NamPower has investigated the following alternatives for power generation (Table 4.1), and a number of options for increased importation.

Table 4.1 Namibia's power generation alternatives. Information sourced from Ninham Shand (2008), ERM (2009) and CCA (2004).

Proposed generating plant	**Capacity (MW)**	**Dispatch**	**Anticipated date to start**	**Life span (years)**	**Limitations and constraints**
Ruacana 4th Turbine-Hydropower Generator	80	Run of the River	2011	30	Not operational during Kunene River low flows
Small Orange River Hydropower	100	Base	2011	30	Numerous small hydropower plants required to generate significant power
Walvis Bay Slop	70-270	Mid Merit	2011	30	Toxic emissions, supply constraints
Kudu Gas	450 – 800	Base	2013	22	Very expensive on the scale required for Namibia, and logistically difficult for gas transportation vessels
Walvis Bay Coal	200 – 800	Base	2014	30	Waste emissions problematic, very expensive, fossil fuels not sustainable, contributor to climate change
Walvis Bay Diesel Peaking Station					Only an emergency supply, high running charges, not efficient under prolonged use, fossil fuels not sustainable, contributor to climate change
Wind	35	CF 35%*	2012	30	See below
Baynes Hydropower	250	Base or Mid Merit	Estimate of 2015	30	Huge capital investment, reliance on cooperation with Angola
Popa Hydropower Scheme	20	Base	Shelved	Shelved	Significant environmental impacts not worthwhile for very small generation capacity

Namibia has a number of new options for importing power in the near or distant future.

Livingstone / Caprivi Link
A 220 kV powerline is currently under construction to link Namibia to Zambia at Livingstone. This project will take advantage of hydropower from the Zambezi River. It will provide up to 200 MW to Namibia.

South Africa

Imports from South Africa via existing infrastructure are likely to continue, though not necessarily at the same rates once existing contracts have been fulfilled. If there are any major new generation plants established in South Africa, this scenario could change.

DRC / Congo River
A long term possibility exists for hydropower generation on the Congo River in the Democratic Republic of Congo. That river has vast hydropower potential. However, establishing the supply infrastructure and the political instability in that country are two significant obstacles to be overcome before that potential can be realized. If Namibia does eventually import power from DRC it will probably be as part of a bigger regional supply scheme to southern Africa.

4.3.2 Renewable energy

NamPower established a target of 10% renewable energy capacity as a proportion of the total by 2011, focusing on selected technologies — including wind, solar and invader bush. A first target of 40 MW should be met by 2011. A macro-economic study of Namibia's power demand and supply options (REEEI 2008) came out strongly in favour of including renewables in a mix of generation sources.

4.3.3 Demand Side Management

Demand side management measures should be given more priority as a matter of urgency. They have been shown to be cost effective and desirable from an environmental perspective. Although NamPower has implemented the distribution of free power-saving light bulbs, there is still much that can be done to reduce the demand, such as time-of-use tariffs (now being implemented in Windhoek) and energy-saving architecture to reduce the need for artificial heating and cooling.

4.3.4 Summary of power generation alternatives relevant to CBEND

Namibia's electricity needs are orders of magnitude greater than a single CBEND plant can contribute. Even replication of 100 CBENDs makes only a 5% contribution to the national demand. This therefore begs the question whether the project should be considered or supported by NamPower. In response, three arguments are relevant:

- Namibia's White Paper on Energy Policy makes the commitment to generate energy from renewable sources and to meet 100% of peak demand. CBEND meets both requirements, as its operation is adaptable enough to efficiently generate at peak times. Of all the renewable energy options for Namibia, the CBEND concept is considered to be the most profitable because of its additional benefit to the economy by improving rangeland productivity.
- The White Paper on Energy Policy also makes the commitment to promote private sector investments in the electricity sector through IPPs and Build-Operate-Transfer schemes. It recognises that this can "contribute to employment creation and economic growth in underdeveloped and rural parts of the country". CBEND provides an ideal opportunity for private sector involvement.
- The time frame of large scale power generation projects is slow compared to the short time in which small scale generation projects (such as CBEND and solar water heating) can be established. Given the appropriate incentives, market forces can provide the necessary impetus for rapid replication of many small units that cumulatively make a significant contribution to power supply.

The above arguments emphasise the need for government and its agencies (NamPower and the Electricity Control Board) to provide an appropriate incentive framework for the CBEND concept to get established and expand.

4.4 CBEND, carbon trading and the REDD programme

The issue of carbon trading has not been investigated since it was agreed during the CBEND SEA workshop that the small size of CBEND-like projects will not be worth the enormous administrative procedure that goes with the Clean Development Mechanism. Furthermore, the auditing that is required for carbon trading is prohibitively expensive for a small operation on the scale of CBEND.

The CBEND concept appears to run contrary to the UN REDD programme (Reduced Emmissions from Deforestation and Forest Degradation) which promotes maintaining forest resources worldwide for their role in absorbing carbon and reducing the rate of climate change. As justification for CBEND, it must be noted that REDD is more focussed on safeguarding large areas of true forest which can potentially make a much greater impact on global CO_2 levels than the relatively small wooded and bush encroached areas of Namibia. REDD is a programme aiming to protect large forested areas from logging; it does not intend to stop the restoration of savannas that have become bush encroached.

Plate 4.4: Rangeland in the Otjiwarongo area, showing good grass cover and presence of desirable large trees (camelthorn *Acacia erioloba* and shepherd's tree *Boscia albitrunca*), and the beginnings of bush encroachment by small blackthorn (*Acacia mellifera)* trees.

5 BASELINE SCENARIO

5.1 Biophysical features

The project area for this SEA is defined by the extent of bush encroachment in Namibia, shown in Figure 5.1. However, the area in the south shaded in blue was excluded because the dominant bush species there (*Rhigosum trichotomum*) is small and produces little biomass. Therefore the area under discussion is limited to the bush encroached areas in the northern parts of the country.

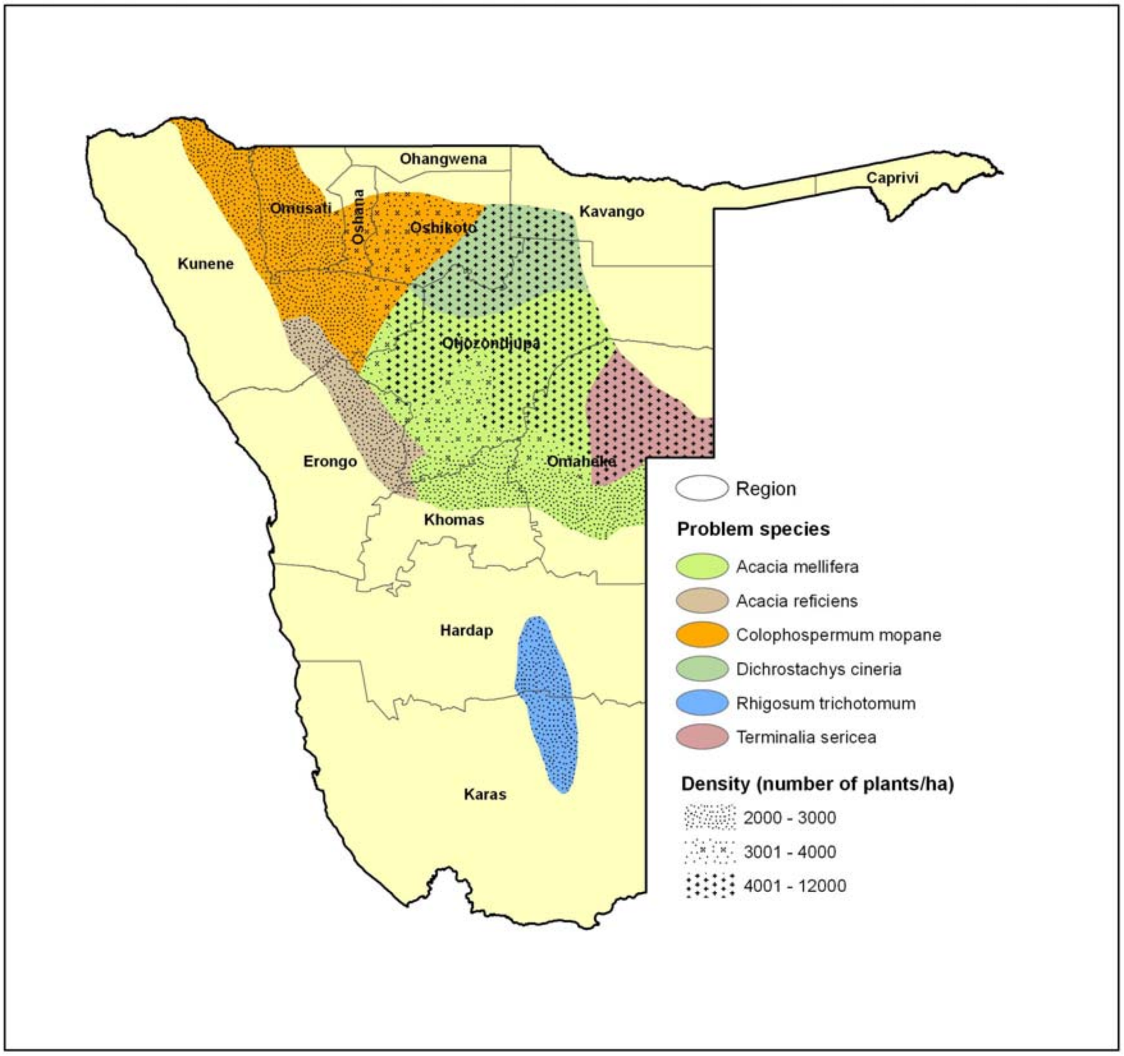


Figure 5.1: Distribution of encroacher bush in Namibia, with the areas where particular species dominate (after Bester 1996).

While *Prosopis* sp is a recognised problem invader species, it was not considered in this SEA as it is mainly distributed along ephemeral river courses and does not form widespread encroached thickets in the same way as the species shown in Figure 5.1. It is possible that there are small, localised areas (e.g. along the Nossob River) that are sufficiently densely encroached by *Prosopis* to make a CBEND-like plant viable. But these areas are relatively small and insignificant in the larger picture of anticipated CBEND replication. Additionally, *Prosopis*, as an alien invasive tree, should be eradicated rather than just thinned, and there are other more economical uses of *Prosopis* wood that make the CBEND approach less preferable for it.

5.1.1 Climate

Most of the information in this climate section is drawn from the Atlas of Namibia (Mendelsohn *et al* 2002).

5.1.1.1 Temperature

Average temperatures mean little in Namibia's climatic extremes so that it is more useful to consider the range of conditions. The mean maximum temperature in the hottest part of the year (November – December) varies over the area within the range 30-36ºC. The mean minimum temperature for the coldest month (July) varies geographically within the range 2-6ºC.

Frost is a limiting factor in the growth, and therefore the distribution, of some encroacher species. The number of days in the year when frost occurs varies from zero in the northwest to as much as 30 days in the southeast. Certain species are less tolerant of frost, e.g. *Colophospermum mopane* (mopane) is limited to the north and northwest of the project area.

5.1.1.2 Rainfall

The project area lies within the higher rainfall areas of Namibia, with the wettest part being the Otavi highlands in the Tsumeb-Grootfontein–Otavi triangle, receiving an average of 550-600 mm. Westwards and southwards it falls off to a low of about 300 mm, which appears to be the lower limit for encroacher bush species to become dominant and thicket forming.

De Klerk (2004) points out that there is a close relationship between bush encroachment and rainfall. The Tsumeb-Grootfontein–Otavi area has the highest densities of encroacher species in Namibia. Not only does the problem increase with higher rainfall but the variability of rainfall also contributes to bush encroachment. Firstly, as with all savannah ecosystems, rainfall is limited to the summer season, almost all the rain falling from November to April with a peak in January to March. Combined with grazing factors, this often results in the veld becoming denuded of grass in the dry season, a factor that gives bush a competitive advantage. Even more importantly, the rainfall is highly variable from year to year and droughts are common. Often several dry years are followed by above-average rainfall years. During the dry years, the veld grasses become depleted. When a wetter cycle begins, there is little grass cover present to compete with bush, which then has a competitive advantage. It has been observed that bush encroachment is not a steady advance every year, but appears to progress in "quantum leaps" associated with wet cycles following several dry years.

Bush encroachment causes "artificial drought" in the sense that the water use of veld in poor conditition due to the bush problem is much lower, producing far less grass than the same amount of rain would produce in healthy savannah grassland. It takes 3–10 times more rain to produce a given amount of grass on degraded rangeland (de Klerk 2004).

Rain falls mainly in the form of heavy convection storms, which has implications for the potential erosion of exposed soil. One of the key advantages of harvesting bush using hand labour is that it leaves the grass and herb layer intact, and does not expose the soil to erosion as machine harvesting does.

5.1.1.3 Humidity & Evaporation

Relative humidity is, like rainfall, highly variable – from a low of 10% in the least humid month, September, to a high of 80 or 90% in the most humid months, February and March.

Evaporation rates are high ranging from about 1,900 to 2,200 mm per year. Potential evaporation exceeds rainfall by a wide margin for the year as a whole, throughout the project area and for most months of the year.

5.1.1.4 Winds

Winds blow from all directions in the study area, with no predominant wind direction, but a slightly higher frequency of winds with an easterly and northerly component. Long periods of calm conditions prevail, especially at night. The highest winds usually occur in the afternoons and present the problem of erosion of any exposed, loose soil. However, winds are not very strong in the area. Typical average wind speeds at 14h00 are in the range 10 -15 km/hour. Gusty conditions with much higher peaks are most common in summer, often just before storms.

5.1.2 Topography

Bush affected areas tend to be plains, while very steep areas are generally unaffected (e.g. most of the Otavi Mountains) or far less affected by bush encroachment (e.g. the mountains east of Windhoek). The reason for this relationship is probably to do with the much higher grazing pressure on the plains. Cattle are less inclined to venture into steep terrain.

5.1.3 Geology & Hydrogeology

It is difficult to generalize about the geology over such an extensive area. The following presents broad generalizations on the relationship between geology, groundwater and encroacher species, but be aware that many local variations will not conform to this superficial analysis.

The area includes extensive karst formations of limestone and dolomite, where surface water readily sinks in so that surface drainage is poorly developed. This is particularly evident in the north and north-west of the project area. The area that is most densely bush encroached (with *Dichrostachys cinerea* and *Terminalia prunioides*) lies in the Tsumeb-Otavi area on such karst formations. Here calcrete horizons in the soil are also common.

In the northwest, where *Colophospermum mopane* is dominant, the highest densities appear to be associated with limestone and dolomite, with lower densities on a wide variety of granitic, metamorphic and sedimentary rocks.

Acacia mellifera is dominant on a wide range of geological substrates. Its density appears to have a closer relationship to rainfall than to geology – the densities falling off as rainfall decreases southwards.

In the eastern parts of the project area are extensive Kalahari sand and alluvial gravels, which have good infiltration capacity. Wherever *Terminalia sericea* becomes dominant, it is always on deep sands, including pockets of Kalahari sands on top of other geological substrates.

Acacia reficiens predominates in the dry area in the southwest on a variety of granitic and metamorphic rocks.

A common feature over much of the project area is the presence of calcrete horizons in the soils. Calcrete deposits are very common in the plains areas that are bush-encroached but it is not clear whether there is any cause-effect relationship to the occurrence of bush.

There is substantial evidence from the Platveld aquifer area (north of Otjiwarongo) of a relationship between the observed decline in groundwater levels over 50 years or more, and the increase in bush encroachment during the same period (Bockmühl 2006). In the same area, Bockmühl reports that where areas of bush have been cleared, the groundwater has showed a corresponding rise in level. This evidence is supported by theory in that it is known that trees use far more water than grass species (De Klerk 2004). Moreover, while grass uses water from the surface layers (up to about 300 mm), trees use soil water from the same zone as well as much deeper levels. Thus trees and bush prevent much of the soil water from penetrating to recharge the groundwater table. This impact is particularly evident in small rainfall events. Or, put another way, it takes a bigger rainfall event for rainfall to penetrate sufficiently to recharge groundwater.

5.1.4 Soils

Soils in most of Namibia are mostly very poorly developed and intrinsically low in nutrients. This is particularly true for the quartzitic Kalahari sands that cover the eastern parts of the study area. Here soil fertility is maintained by recycling nutrients released from decaying organic matter in the soil, and from bird, animal and insect droppings. Kalahari sands also have poor water retention properties due to their lack of clay content.

Shales / shists and soils derived from igneous rocks have slightly higher nutrient status. However, everywhere the hot, dry climate impedes the action of soil organisms that process detritus and fix nitrogen. Almost throughout the project area, the organic content of soil is very low, and there is seldom a distinct “A-horizon” or organic layer in the soil.

The calcrete horizons mentioned above may impede or delay infiltration locally, which may benefit the affected soils.

Where soils become degraded by excessive bush encroachment, soils often become ‘capped’ i.e. they develop a hard baked surface in which it is difficult for any grass to get established. This, in turn, increases runoff of rainfall and reduces infiltration. Soil erosion may then ensue.

Bush clearing may also expose soil to erosion if not done sensitively. Bush thinning rather than bush clearing is recommended in the literature, and CCA (2010) recommends that slopes steeper than 5% should not be cleared by machine. This recommendation could be relaxed with hand labour, instead simply reducing the degree of bush thinning that takes place on steeper slopes. Vegetation on slopes exceeding 12%, however, is best left alone to prevent soil erosion.

De Klerk (2004) emphasises the importance of trees and bush for the maintenance of soil fertility in savanna ecosystems. Grass production and biodiversity are low in very densely encroached stands, and improve with thinning of bush. However, if all the bush and trees are removed, the soil fertility declines again. The decline is most rapid in sandy soils. This is not only because of the necessary recycling of soil nutrients, but also because of the effects of trees/bush on microclimates – providing leaf litter, shade, increasing air and soil humidity, reducing wind speeds, and providing the conditions that allow soil organisms, including nitrogen-fixing bacteria to operate. These benefits, in turn, encourage the more nutritious species of grasses – the perennial (or climax) species, which often thrive best close to trees or bush.

As a rule of thumb, de Klerk (2004) suggests that the number of tree equivalents per hectare should not exceed twice the long term mean annual rainfall. (A 1.5 m high tree is one tree equivalent. A tree of 3 m is two tree equivalents.) Thus an area with a rainfall of 450 mm should not have more than 900 tree equivalents, and these should be made up of a diversity of size classes. In general the smaller bushes should be targeted for removal – keeping especially the large trees (over 4-5 m in height).

5.1.5 Vegetation Types

Table 5.1 below shows the vegetation types according to Giess in the project area and the dominant encroacher bush species according to Figure 5.1. Note that there is not a perfect correspondence between the two and such broad generalisation inevitably conceals many local variations.

Table 5.1

Giess' Vegetation Types	**Related Dominant Encroacher Bush Species**
(6) Mountain savanna and karstveld	*Dichrostachys cinerea* (& *Terminalia prunioides*) Most of the Otavi Mountain Highlands are almost unaffected by encroacher bush, with some exceptions in the foothills. However, the plains that make up most of the land area are often densely encroached, especially but not exclusively by the above two species.
(7) Thornbush savanna (tree & shrub savanna)	*Acacia mellifera* at higher densities
(8) Highland savanna (bergthorn savanna)	*Acacia mellifera* at lower densities
(11) Tree savanna and woodland (northern Kalahari)	A poor correspondence but intruding into Giess' types (6, 7 & 12)
(12) Camelthorn savanna (central Kalahari)	*Terminalia sericea*
(4) Semi-desert and savanna transition (escarpment zone)	*Acacia reficiens* at lower densities of encroachment
(5) Mopane savanna	*Colophospermum mopane.*

Giess' descriptions of the above areas are quoted below – in so far as they are applicable to the project area. Since part of the objective of rangeland management is to restore bush encroached areas to their former, more open state, it is informative to consider Giess' descriptions, quoted below.

(6) Mountain Savannah and Karstveld

> The Mountain Savanna has a very wide distribution and embraces the whole Karstveld, excluding the areas covered by mopane. Sandveld patches occur in this vegetation. The Mountain Savannah is characterised by *Kirkia acuminate*, *Gyrocarpus americanus*, *Fockea multiflora*, *Berchemia discolour*, *Pachypodium lealii*, *Croton* spp., *Cyphostemma juttae*, *Securidaca longepedunculata*, *Cissus nymphaeifolia*, *Euphorbia venata*, *Olea europeae* subsp. *africana*, *Moringa ovalifolia* and many others.
>
> The flats between mountains are covered with shrubs and small trees of *Combretum apiculatum*, *Dichrostachys cinerea*, as well as species of *Croton* and *Acacia*. The larger trees consists mainly of *Sclerocarya birrea* subsp. *caffra*, *Spirostachys africana*, *Peltophorum africanum*, *Ficus cordata*, *F. sycomorus*, *F. thonningii*, and *Combretum imberbe.* On sandveld patches *Lonchocarpus nelsii*, *Terminalia sericea* and *Acacia* speciea are common. *Terminalia prunioides* also occurs quite frequently in this region. To the east a palm savanna is found, in which *Hyphaene petersiana* is conspicuous.

(7) Thornbush Savanna (Tree & Shrub Savanna)

Thornbush Savanna is the dominant vegetation type over the central region of Namibia. The vegetation varies but the characteristic feature is grassland with trees and bigger shrubs in dense or open clumps of varying size. Over large parts of this region *Acacia* spp. are very dominant and in some places bush encroachment by *Acacia mellifera* is taking place. The vegetation is composed of *Acacia reficiens*, *A. hebeclada*, *A. mellifera*, *A. erubescens*, *A. fleckii*, and in some areas *A. tortilis.* A*cacia erioloba* occurs mostly in Riverine Woodland on the alluvial banks of rivers. *Boscia albitrunca* is quite common in some localities. *Lonchocarpus nelsii* is common in the more sandy areas, while *Combretum apiculatum* often predominates on limestone and rocky outcrops. *Ziziphus mucronata* is found throughout most of this zone.

(8) Highland Savanna (Bergthorn Savanna)

This veld type characterizes the central, mountainous areas, namely the Khomas Hochland and Windhoek Bergland. It is characterised by *Acacia hereroensis* together with *Combretum apiculatum*, *Acacia reficiens*, *A. hebeclada*, *Euclea undulata*, *Dombeya rotundifolia*, *Tarchonanthus camphoratus*, *Rhus marlothii* and *R. dinteri*, *Albizia anthelmintica*, and *Ozoroa crassinervia*. Along the riverbeds on alluvial banks *Acacia erioloba*, *Rhus lancea*, *Ziziphus mucronata*, *Acacia karoo*, and *Olea europea* subsp. *africana* occur.

The original grass cover consists of *Anthephora pubescens*, *Brachiaria nigropedata*, *Cymbopogon* spp., *Heteropogon contortus*, *Hyparrhenia hirta*, *Digitaria eriantha*, *Sporobolus* spp., and others. In many parts these valuable grasses are becoming sparse either because of overgrazing or injudicious selective grazing.

(11) Tree Savanna and Woodland (Northern Kalahari)

This vegetation type is the only real tree savanna or woodland in Namibia. Only a small portion overlaps with the bush encroached areas shown in **Figure 1**, so the detailed description is of little relevance here.

(12) Camelthorn Savanna (Central Kalahari)

Camelthorn Savanna is an open savanna or sometimes parkland with the trees in small groups, the typical being *Acacia erioloba*. Small or large shrubs of *Acacia mellifera* sometimes form dense thickets. Young trees of *A. erioloba* may be very common in places. Common shrubs are *Acacia hebeclada*, *Ziziphus mucronata*, *Tarchonanthus camphoratus*, *Grewia flava*, *Rhus ciliata* and *Ozoroa paniculosa*. Interspersed in the Camelthorn Savanna are stands of *Terminalia serciea* which occurs mainly on white sand and may form woodland patches. These white sand areas are mainly the habitat of hard grasses such as *Eragrostis pallens* and *Aristida stipitata*. *Terminalia sericea* also grows in red loamy sand with *A. erioloba*.

Tarchonanthus–Grewia veld is found mostly on open flats where the shrubs attain a height of only 3-4m. *Acacia hebeclada* occurs in the form of either a shrub or a small tree and these two forms may be found growing together. The vegetation dominated by shrubs is closely related to the Camelthorn Savanna and the two grade into each other, and in the west these two types grade into the Highland Savanna.

(4) Semi-desert and Savanna transition (Escarpment zone)

This vegetation type is characterised by a great variety of species, many of which are endemic. Typical species include *Euphorbia guerichiana*, *Cyphostemma* spp. and *Moringa ovalifolia*. Two species of *Acacia* which are confined to this vegetation type, *A. montis-usti* and *A. robynsiana*, are found from the Brandberg to the southern Kaokoveld. *Acacia senegal* and *A. tortilis* also occur mainly in the west but occasionally may be seen further inland.

Particularly characteristic of this zone are the various species of *Commiphora: C. virgata*, *C. giesii*, *C. saxicola, C. anacardifolia*, *C. glaucescens*, *C. kraeuseliana*, *C. multijuga*, C. *oblanceolata* and *C. wildii*.

Some of the woody species in this zone, which has 100 mm average annual rainfall, also extend eastwards into the Otavi Mountains with over 500 mm per year.

(5) Mopane Savanna

Colophospermum mopane is the characteristic species, growing either as a shrub or as a tree depending on local conditions. It sometimes forms dense woodland and other times is a short stemmed shrub intermingled with other trees. The genus *Commiphora* is also well represented, as is the family Acanthaceae. Mopane savanna also has a number of species in common with Mountain Savanna.

Based on experience and consultations with botanists, it is a fairly reliable generalisation that bush encroachment is dominantly a feature on the plains areas. Steep slopes, koppies and outcrops (e.g. near Otjiwarongo), and the karst mountains of the Otavi Mountain Range are seldom much affected by bush encroachment. Therefore these high areas still support a high diversity of trees, many of which are endemic or protected species.

Riverine areas are often lined with larger species of trees, such as *Acacia erioloba.* These are important ecological corridors and all areas within 100 m of a watercourse are protected under the Forest Act – forbidding felling without a permit.

5.1.5.1 Definition of encroacher bush

De Klerk (2004, p.2) defines bush encroachment as...

> *"the invasion and /or thickening of aggressive undesired woody species resulting in an imbalance of the grass:bush ratio, a decrease in biodiversity, and a decrease in carrying capacity and concomitant economic losses*".

De Klerk (2004) provided a list of encroacher bush species, which was updated by Strohbach (2009). The updated list is contained in **Appendix B.** We prefer to use the term "encroacher" for indigenous species and reserve the term "invader" for alien invasive species. For the purposes of CBEND, the trees in **Appendix B** (encroacher and alien woody species) should be the only species targeted for harvesting.

5.1.5.2 Definition of browser species

Bush and tree species that are eaten by wildlife and domestic livestock are referred to as browser species. Cattle will even eat the leaves of several species, especially in times of drought. **Appendix C** provides a provisional list of the species that are known to be important for browsers. Some of the legally protected species are also important for browsers but these have been listed in Appendix C instead.

5.1.5.3 Definition of protected species

Many species of trees and shrubs are legally protected under the Forest Act or the Nature Conservation Ordinance. A list is contained in **Appendix D**. These should **not** be harvested. For a few species farmers report that they become thicket forming, e.g. *Peltophorum africanum* and *Spirostachys africana*. However, it is our view that protected species should not be harvested because the extent of thickets of these species is not such that it becomes a threat to rangelands. The only exception is *Colophospermum mopane* (mopane) which is also listed as an encroacher species. An exception should be made to allow harvesting of this species in certain areas.

The various protected species are frequently confused with encroacher species so that great care and supervision is needed to ensure that they are not accidentally felled.

5.1.6 Yields of bush

DRFN (2009) estimated that 10 t/ha could be harvested from some 10 million ha. Thus the standing crop was estimated at 100 million tonnes.

Energy for Future conducted harvesting trials using a large track-mounted machine (CCA 2010). They achieved yields of 10 – 30 t/ha in three bush types (*Dichrostachys cinerea–Terminalia prunioides*, *Acacia mellifera-Terminalia sericea*, and *Acacia reficiens*). Much of this harvest included medium sized trees over 4 m in height, not just 2 m bush. However, DRFN's figure of 10 t/ha is probably a useful but appropriately conservative figure on which to base estimates of the areas required to support a CBEND gasifier.

Naturally, both the density of bushes and the standing crop will vary from place to place, even on a single farm.

Rates of regrowth of bush are not known, and evidence comes mainly from isolated case studies and reports by farmers. For example, Eberhardt (pers. comm. 2010) harvested an area of *Acacia mellifera* on his farm ten years ago, and in October 2009, the regrowth was standing 1.5 m tall in a fairly even aged stand that was still open enough for cattle to walk through. Coetzee (pers. comm. 2010) cleared an area of *Dichrostachys cinerea* by cutting, and reported that after 4 years it had regrown so densely that cattle could not get into these thorny thickets to graze.

However, there is simply not enough data available on the rates of regrowth of the various bush species in different conditions and under different rainfall cycles (dry versus successive good year cycles).

5.1.7 Propagation of bush species and responses to cutting

Different species have different modes of propagation and different responses to being cut. The two that are best known are *Acacia mellifera* and *Dichrostachys cinerea*. A comparison between these two (Table 5.2) illustrates the fact that not all bush encroached areas can be treated equally to achieve a given result.

Table 5.2 Comparison between *Acacia mellifera* and *Dichrostachys cinerea* with regard to seed generation and response to cutting.

Acacia mellifera (blackthorn)	*Dichrostachys cinerea* (sicklebush)
Produces large numbers of seeds but they are not viable from one year to the next. There is therefore no seed bank in the soil	Produces large numbers of seed that remain viable on the plant or in the soil for years. Seed is stimulated to germinate by light, so when the canopy is removed, the seeds grow.
Plants coppice readily after cutting, although this is somewhat dependent on the time of year. If cut when the plant's reserves are low (May – July) it is more likely to die.	Plants coppice readily after cutting, and they are not very susceptible to being killed in this way. Since growth is from seed and coppicing, the situation often ends up with a denser infestation than before.
Seeds are not spread by being eaten by animals.	Seeds may germinate after being eaten and deposited in the dung of animals.
This species is not much favoured for browsing by goats.	The new growth is very palatable for goats to browse. Some farmers report some success in managing regrowth by means of intensive browsing by goats.

Other Acacia species are thought to have more durable seeds than *A. mellifera* but detailed information is not available. Other Acacia and Terminalia pods are eaten by wildlife and this is assumed to be one of the mechanisms of dispersal.

The differences between species have implications for the aftercare of bushed areas that have been harvested. Since *A. mellifera* does not leave a seed bank in the soil but regrows from many of the stumps, it is understood to be easier to control following the initial cutting. However, because *D. cinerea* grows from stumps and seed and the germination is stimulated by light, this species tends to become denser following cutting. It therefore requires a greater level of aftercare if the intention is to produce sustainable grazing resources.

5.1.8 Farming

The main farming activities that take place in Namibia's bush encroached areas are predominantly cattle farming (mainly for commercial marketing) in the freehold areas, mixed large and small stock farming (with limited marketing, mostly for domestic consumption) in the communal areas, and wildlife and ecotourism as a growing land use on both freehold and communal land.

Since the CBEND approach is about restoring productivity of rangelands, it can benefit (both large and small) livestock farming as well as game ranching and ecotourism. The approach emphasises grid infeeding which limits its likely replication to the freehold farming areas as that is where most powerlines that can be infed, occur (Figure 5.6). However offgrid areas (viz. predominantly communal areas) would equally benefit from the improvement in rangeland productivity,

5.1.9 Fauna

5.1.9.1 Birds

Few studies have specifically addressed the question of the impacts of bush encroachment or bush clearing on birds. The most relevant is a report compiled by Simmons (2009) for a bush-harvesting proposal for the cement plant near Otavi. The study was based on a 75 km radius from the cement plant. This is also within the most densely encroached part of Namibia. He listed some 278 species based on Bird Atlas data, but pointed out that the number of species in bush encroached areas is known to be considerably reduced. Although Simmons' study focused on a limited area, his findings have much wider applicability.

The species that are of greatest conservation concern – Red Data species – are all raptors. Simmons' list of Red Data species for his limited study area is presented in **Appendix E1**, but with the possible exception of a few species it also has wider applicability. Raptors will actually benefit from some bush clearing, because dense bush makes it difficult for them to hunt. Vultures, in particular, are expected to benefit from the opening up of bushed areas as they need space in order to get airborne. In dense bush they can't get access to carcases. Raptors that nest in trees are more likely to use large trees rather than bush, so all large trees (greater than 4 m high) should be retained.

The critically endangered Cape Vulture is likely to benefit from bushed areas being restored to open grasslands. Lappet-faced Vultures build conspicuous nests in large trees and return to the same nest year after year to breed. It is therefore recommended that sites close to all large raptors nests should be avoided when harvesting bush.

There are 7 near-endemics that can be found in the bush-encroached parts of the country; i.e. those species whose main distribution lies within Namibia. The list is contained in **Appendix**

E2. All of the endemic species are widespread in Namibia and are not rare here. None of the near-endemics favour dense bush. The least common is Hartlaub's Francolin which likes mountains and rocky habitat. It is more likely to be encountered in the drier western parts on rocky hillsides rather than mopane dominated plains.

Simmons estimated that, of about 30 species that are likely to be found in thorn bush thickets, only 6 species are reliant on it. These are listed in **Appendix E3**. All six of these are common in Namibia, so even if bush clearing is detrimental to them on a local level, the species will not be significantly affected in Namibia.

In addition to leaving all large trees (taller than 4 m, including large dead trees), it is recommended that bush clumps of varying sizes should be left - including some between 1 and 4 ha - as refuge and nesting habitats.

5.1.9.2 Mammals, Reptiles & Amphibians

Griffin (2009) produced an area-specific list of the species that are known or expected to occur within a 75 km radius of the cement plant near Otavi. A summary of that information is provided in **Appendix F**, which focuses on species of particular conservation concern. The following discussion is based on this data. We do not have such a list for the whole area of Namibia that is bush-encroached, but this information will also have wider applicability in savanna areas.

- Two species of frogs may be of conservation concern but data is deficient.
- Two species of tortoises are uncommon and vulnerable.
- At least five species of snakes are rare, including two species of python.
- Small cats like serval, civet and genet are rare but data deficient.
- Cheetah are of international conservation concern.
- Both the brown hyaena and spotted hyaena are rare and conservation dependent.
- Small inconspicuous animals like weasels, pangolins and hedgehogs are rare or data deficient.
- Some large grazers such as red hartebeest and blue wildebeest are uncommon and conservation dependent.

Unlike birds that range quite widely, some of the mammals, reptiles and amphibians may have more restricted localities. However, what is known is that the plains areas are more homogeneous in habitat conditions over large areas than mountains and koppies. In highland areas conditions may change rapidly with distance and the niches thus created often result in quite specific faunal assemblages in some localities. This is generally true in Namibia (pers. comm. Griffin 2009). For example, species of reptiles that have quite specific habitat preferences are more likely to be found in mountainous areas than on the plains.

IDC (2003) states that 19 species of mammals are associated with dense bush cover in Namibia, while seven species prefer ecotone areas (transitional areas). Bush habitat is used for shade, forage, nesting sites, refuge or cover from which to stalk prey.

We will consider briefly groups of animals that may be particularly affected by bush encroachment and bush harvesting.

Trees and bush are particularly important for true browsers such as kudu, duiker, dik-dik, giraffe, black rhino and elephant. However, even for these species the bush can be too dense to permit access to food plants. Even grazers such as blesbok that normally prefer open grasslands, also seek shade in bush during the midday heat.

Carnivores depend mainly on bush for shelter (e.g. genets in cavities in large trees) and leopards for stalking prey. Rodents, mongoose and other small mammals use it for refuge.

Mature trees are very important for cavity users, including the African bush baby, which feeds on Acacia gum, and four bat species use cavities in large trees.

Ecotone areas are important for at least 7 species of mammals. These would benefit if bush patches are left, especially if elongated rather than round areas are left (i.e. with a high edge to area ratio).

The groups of mammals most likely to be affected by bush clearing will be the browsers and cavity users. Browse bushes, such as *Grewia* species need to be left, as well as all large trees – whether dead or alive – for nesting/roosting sites.

Jeffares & Green (2000) considered it likely that bush thinning would result in a shift in the proportions of game species. Species requiring dense bush (dik-dik, duiker, eland, giraffe, kudu and steenbok) are likely to decline unless some large patches of bush are conserved. Grassland species, which rely on speed to evade predators (blue wildebeest, oryx, red hartebeest, warthog and zebra) may increase.

Cheetah will benefit by bush clearing as they need open habitat to chase down their prey. Only about 10% of the world's free ranging cheetah population is left and Namibia has the largest remaining population of free range cheetahs in the world, of which about 90% are found on commercial farmlands (de Klerk 2004).

Habitat change will benefit some mammals and disadvantage others, a fact that makes it difficult to generalise about the impacts on mammals. But based on the fact that encroacher bush is seen as a degraded state of savannas, activities that help to restore the original diversity of habitat, including some open grasslands, are likely to be beneficial overall – leading to increased diversity of species in areas that are currently bush encroached.

At least 23 snake species and 14 lizard species are closely associated with bush/trees in the north-central parts of Namibia. Of these, 6 snake species live in trees, while 14 species use trees for thermoregulation, foraging or for refuge when disturbed. Three species use rotting logs.

Snakes are highly vulnerable to being killed by labourers and farmers. Some slow moving species are particularly vulnerable e.g. python – which are rare and of conservation concern. Snakes are important ecologically. They help to keep prey species, such as hares, under control.

Five species of reptiles are considered arboreal. Nine other lizard species are often associated with bush and trees for thermoregulation or refuge. These include slow moving species such as chameleons, which may be vulnerable to persecution by labourers, although not rare.

Reptiles are not inclined to move long distances and they are therefore the group most affected by bush clearing. Namibia does have many endemic reptile species, but most of the endemics occur well to the west of our study area (Griffin 1998) and will not be affected.

Tortoises and turtles are vulnerable to being killed by vehicles or machines, or by people who take them to eat.

It is recommended that, in any area where bush thinning occurs, some bush clumps be left unharvested to provide refuge, browse, nesting sites and the other services that bush provides to fauna. Occasional patches of 1 – 4 ha of bush should be left unharvested. Furthermore all large trees (over 4m), dead or alive, should be left to provide habitat for those species that need them. No protected species of trees should be harvested.

The CBEND approach of bush thinning has the potential to restore habitat diversity. Improved diversity of faunal species should follow if the above recommendations are implemented.

5.1.9.3 Arthropods

There is very little data available on arthropods and certainly nothing that is specific to the project area. De Klerk (2004) and Joubert (2003) draw attention to the fact that certain insects are host-specific to certain plant species. For example, the Topaz Spotted Blue Butterfly (*Azanus jesous jesous*) feeds on the flowers and buds of *Dichrostachys cinerea*. The larvae of the Western Marbled Emperor Moth (*Heniocha dyops*) is dependent on *Acacia mellifera, A. hereroensis*, and *A. erubescens* for food. There are likely to be many more such associations that are not and will not be known in the near future.

There would be little point in trying to undertake a comprehensive documentation of such associations between particular plant species and arthropod species. However, the existence of such associations underlines the fact that all plants, including encroacher species, play an ecological role in Namibia. The encroacher species are not aliens, they are indigenous, and the fact that Namibian landscapes and plant communities are so old in geological time means that complex ecological relationships and inter-dependencies have developed. Therefore it is important to leave some encroacher bush, as well as all other plant species that are present.

5.2 Socio-economic characteristics

The CBEND project has the potential to help reduce poverty in Namibia’s rural areas through the provision of job opportunities. This is its main motivation for support from the Rural Poverty Reduction Programme (RPRP), which hopes to achieve greater levels of employment and stability of employment in the rural sector, in comparison to employment in the charcoal industry which is mostly informal and workers come and go with very little job stability.

In the following sections an attempt has been made to depict existing socio-economic trends and concerns in Namibia related to: national and rural incomes; poverty; the HIV/AIDS epidemic; unemployment; and gender inequity. Resettled farmers, as potential labourers for CBEND operations, are considered, and lessons learnt from the charcoal industry are drawn upon to help guide the CBEND initiative with respect to best practice.

For the purposes of this section, the land on which bush encroachment occurs has been divided into communal and freehold farming areas (Figure 5.2).

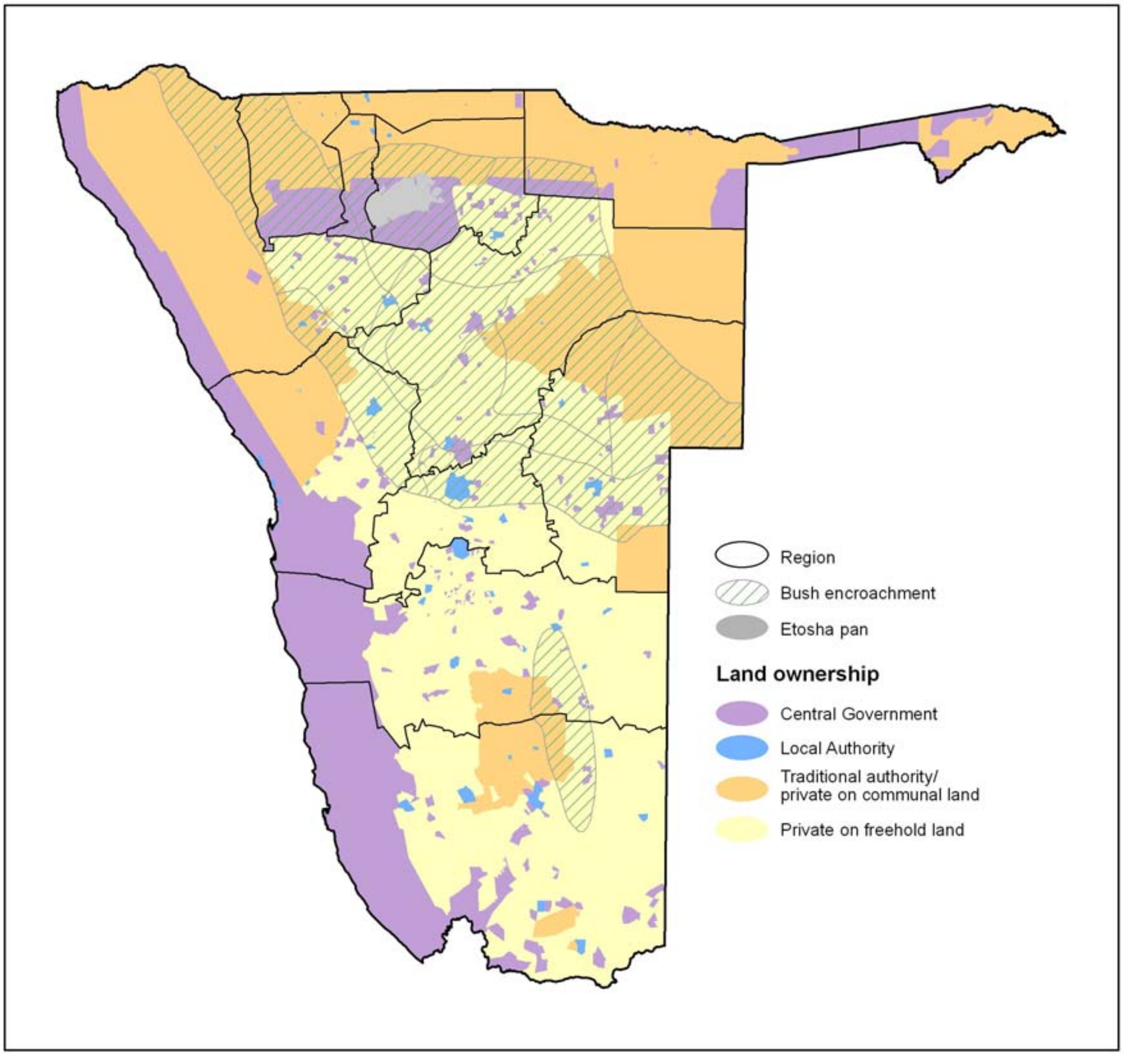


Figure 5.2 Areas of bush encroachment in Namibia mapped against communal and freehold land ownership, as well as land owned by Government (mostly protected areas).

Namibia's northern regions that have bush encroached communal land support an estimated 1.025 million people (56% of Namibia's population). The land is populated predominantly by farmers that have communal usage rights to land for livestock and small-scale cereal production. Produce is used largely for domestic consumption (Mendelsohn 2006). The northern communal lands support a high density of people. They are generally overstocked, overgrazed and in areas that are not bush encroached, suffer from severe deforestation (MET 1998).

The regions that have bush encroached freehold land support an estimated 0.715 million people (39% of Namibia's population) – a high percentage of which reside in urban centres (NPC 2006). Farmers in this area have exclusive ownership of their land which is used predominantly for raising cattle for commercial use (Mendelsohn 2006). Unpublished work conducted in the 1990s by F.W.Bester (in MET 1999) estimated that almost 50% of the commercial farms in Namibia were bush encroached and that this form of land degradation was responsible for causing a decline in cattle carrying capacity by between 20 and 90%.

5.2.1 Namibia's human poverty index

The human poverty index (HPI) is used universally to provide quantitative representations of three important human development dimensions *viz*. a long and healthy life, knowledge, and a decent standard of living. Indices employed to equate HPI pertain to life expectancy, educational attainment and income.

Although Namibia has made progress towards the first of the Millennium Development Goals (to eradicate extreme income poverty[1]) and overall educational attainment continues to improve, recent quantitative analyses of HPI suggest that human poverty[2] levels in Namibia are in fact increasing (UNDP 2007) and that:-

- Rural areas are still significantly higher than urban areas in all three dimensions of human poverty.
- Erongo and Khomas have the lowest levels of human poverty in Namibia (human poverty levels in <20% of the population), compared to Oshikoto, Omusati and Kavango, where human poverty levels approach 50% (UNDP 2007).
- Since 1991, the HPI has fallen in only five regions. These are Erongo, Otjozondjupa, Omaheke, Kunene and Kavango. In the remaining eight regions the HPI is increasing – a trend that is particularly noticeable in Ohangwena, Omusati, Oshikoto and Kavango (*ibid).*

5.2.2 HIV/Aids incidence as a driver of human poverty in Namibia

An underlying cause of increasing HPI in Namibia is the HIV/Aids epidemic (the primary driver of falling life expectancy[3]) which is so strong that it has more than offset the positive effects of improvements in the other dimensions of human development.

The 2008 National HIV Sentinel survey of prevalence rates in pregnant women aged 15 -49 (MoHSS 2008a) reports that :-

- National prevalence of the disease in this group of Namibians is currently 17.8%.
- There is little difference in HIV prevalence between rural and urban areas.
- The disease is concentrated amongst mobile populations (e.g. those linked to the mining industry and at border entry/exit points). No data was available on the incidence of HIV/Aids amongst charcoal workers (and therefore, potential CBEND workers) but it is assumed that this is also a high risk group as they tend to be transient.
- Of all the health districts that fall within bush encroached areas, Okahao and Tsandi (Omusati Region) have amongst the highest prevalence of HIV/Aids in the country (27% and 26% respectively). Similarly the Oshakati district (Oshana Region) and the Onandjokwe district (Oshikoto Region) suffer above average HIV/Aids prevalence (22% each).
- The average HIV/Aids prevalence amongst pregnant women aged between 15 and 49 in the combined communal regions where there is bush encroachment (an estimated 20%) is higher than the national average and considerably higher than the encroached freehold farming areas (14%).

[1] 'Income poverty' is defined in purely financial terms. "Poor" households are those that have a monthly expenditures of less than N$ 262.45 per adult, and "severely poor" households as those with expenditures of less than N$ 184.56 (NPC, 2008)

[2] 'Human poverty' is a measure of deprivation in the most essential capabilities of life, including leading a long and healthy life, being knowledgeable, having adequate economic provisioning and participating fully in the life of the community.

[3] Life expectancy fell by 11 years (men) and 13 years (women) to 48 and 50 respectively between 1991 and 2001.

- The incidence of orphans and vulnerable children (OVCs) – a major consequence of the HIV/Aids epidemic – is highest in Namibia's rural areas with the lowest wealth quintiles. Amongst the highest incidence of OVCs in Namibia occurs in the Omusati, Oshana, Oshikoto and Kavango regions which all report between 31 and 37% incidence (MoHSS 2008).
- The number of HIV/Aids cases in Namibia is expected to increase for several years.

Projections for HIV/Aids are presented in Table 5.3 and give some indication of how Namibia's male work force will be impacted upon by this disease in the short term. Probably the majority of CBEND labourers (as with the charcoal industry) will be male.

Table 5.3. Estimated numbers of HIV+ people and males in Namibia (2010 – 2013) (MoHSS 2008b

Year	Numbers of HIV^+ Adults (15+)	Numbers of HIV^+ children (0-14)	**Total**	Numbers of HIV^+ Adult males* (15 +)	Total number of HIV^+ males *
2010/2011	217,000	14,000	**231,000**	105,000	112,035
2011/2012	225,000	13,800	**239,000**	109,000	115,915
2012/2013	234,000	13,300	**247,000**	113,000	119,795

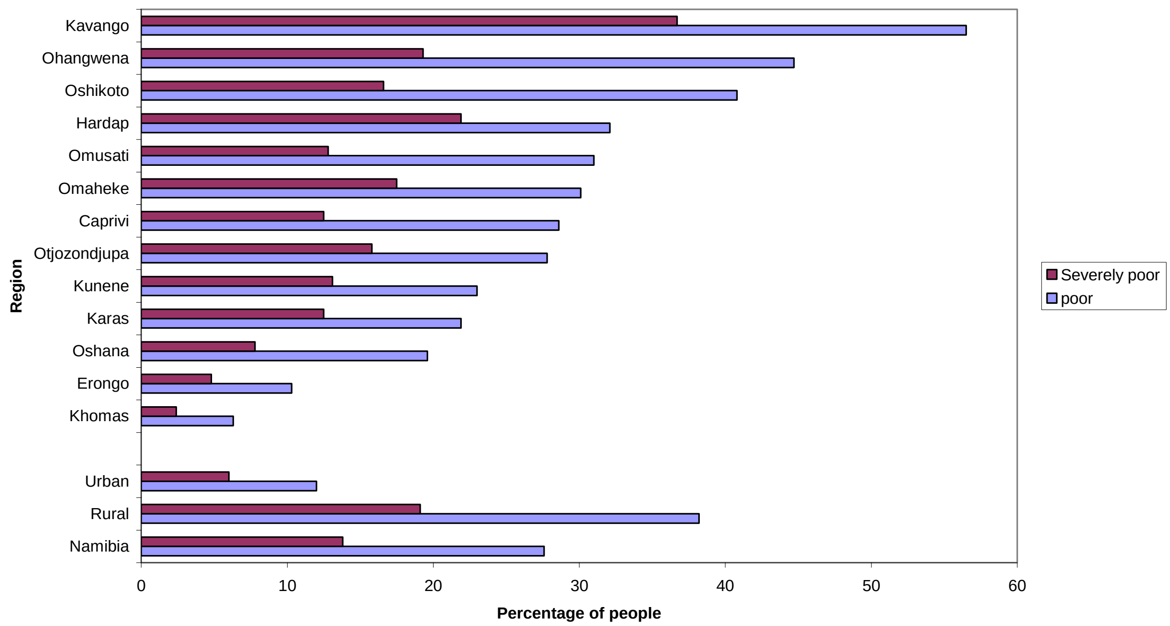
* An estimated 48.5% of Namibia's population are males (MoHSS 2008)

5.2.3 Income poverty incidence by locality and region

In 2003/2004 an estimated 41% (750,000) of Namibians could be classified as either poor or severely poor (NPC 2008). The incidence of income poverty varies considerably between the regions and between urban and rural areas.
Figure 5.3 shows that :-

- The incidence of poor and severely poor households in rural areas is more than triple the incidence in urban areas.
- The highest incidence of poverty is found in the Kavango region (home to approximately 7% of Namibia's population and an estimated working-age population of 113,990) where 56% are poor and 37% are severely poor. Kavango is also home to the greatest percentage of all poor households in the country – more than 17%. More than 60% of all poor households in Namibia are found in the combined regions of Kavango, Ohangwena, Oshikoto and Omusati.
- Income poverty incidence is lowest in Khomas (home to 14,1% of Namibia's population and an estimated working-age population of 186,550) and Erongo (home to 5,4% of Namibia's population and an estimated working-age population of 70,732) with 6 and 10% poor and 2 and 5% severely poor, respectively.

Figure 5.3 Incidence of income poverty by region in Namibia 2003/2004 (NPC 2008)



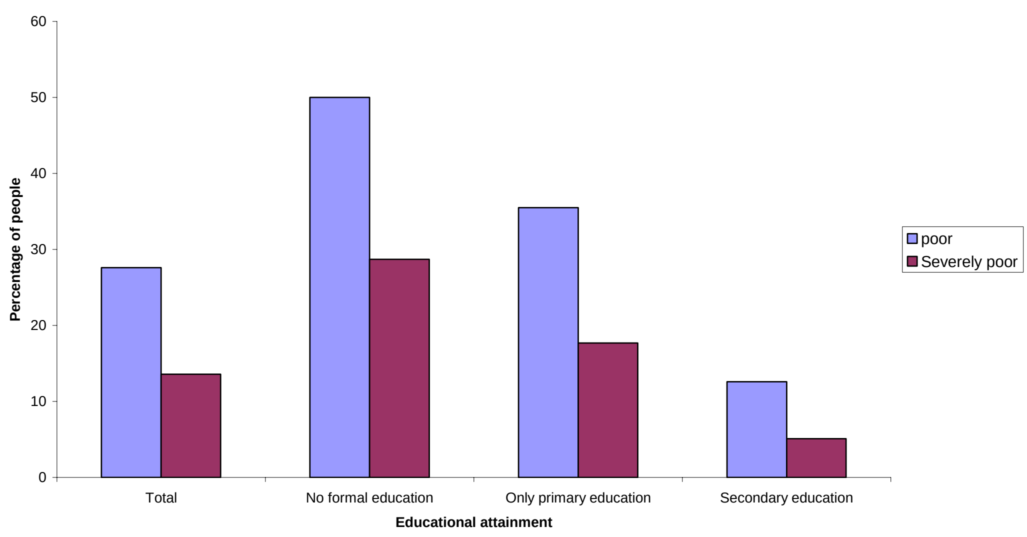
5.2.4 Poverty by educational attainment and per capita earnings

In 2004 more than half of Namibia's labour force was unskilled and un- or semi-educated (NPC 2006).

As shown in Figure 5.4:

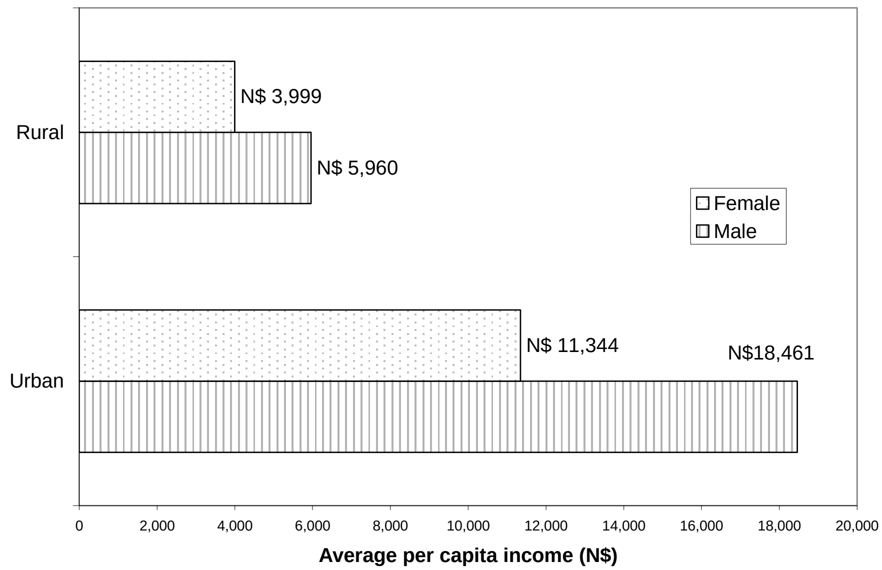
- Amongst the heads of household that have no formal education, 50% are poor and 26.7% are severely poor.
- Of all poor households, 83.5% have a head of household that has either no formal education or has only completed primary school.

Figure 5.4. Educational attainment of heads of households in Namibia and poverty (NPC 2008)



Large differences exist regarding educational attainment between rural and urban populations. 23% of the population in rural areas have no formal education compared to 7% in urban areas (NPC 2006). Furthermore, the average per capita earnings in urban areas is considerably higher than in rural areas (Figure 5.5).

Figure 5.5 Average per capita income by urban/rural areas and sex of head of household [NPC,2006]



5.2.4.1 *Poverty and gender inequity in Namibia*

The gender aspect of poverty in Namibia is illustrated by the following findings (NPC 2006; NPC 2008):-

- Poverty levels in Namibia are highest among rural households that are female-headed.
- On average women earn 30% less than men in rural areas and 40% less than men in urban areas (Figure 5.5).
- Urban areas have a predominance of males between the ages of 15 and 60 when compared to rural areas. As a result, increasing numbers of rural households are headed by women (43% as opposed to 37% in urban areas). This is particularly true in Ohangwena, Oshana, Oshikoto and Omusati.
- When female- and male-headed households are compared, the former have consumption levels that are almost 5% lower, even when differences in locality, level of education and number of people in the household are taken into account.

In order to alleviate some of the inequity that women in Namibia still face, the CBEND initiative should make every effort to employ both sexes. While some tasks such as wood chopping are male-dominated, there are others in the CBEND setup which can readily be done by women.

5.2.5 Rising unemployment and rapid urbanization in Namibia

In 2004 about two-thirds of Namibia's unemployed fell into the most productive age group of 16-45. Unemployment continues to rise in Namibia and the MoLSW's most recent Labour Survey[4] states that by 2008 it had reached 51,2%.

If manual bush clearing for the CBEND initiative is pursued, the majority of the labour used is likely to be male. The estimated number of males aged 15 - 49 that were unemployed in the combined northern regions that are bush encroached in 2006/2007 (MoHSS 2008) was 119,000.

Because opportunities for employment, business and per capita earnings in Namibia are highest in the larger towns, rapid rates of urbanization (estimated at 5 – 6% per annum in 2001) (Mendelsohn *et al*. 2002) continue to draw young, able bodied people away from rural areas. In 2004, 60% of the population in rural areas were under the age of 20 or over the age of 75 (NPC 2006). About 28% of Namibia's population was urban in 2006 (MoHss 2008) but by 2020 between 75 – 85% could have settled in the larger towns (Mendelsohn *et al.* 2002).

5.2.6 Access to local services and infrastructure

CBEND plants must be less than 500 m from a suitable powerline (33, 22 or 11 kV) where infeeding into the grid can take place. Large tracts in the northern communal areas exist far from such powerlines (Figure 5.6). This will limit the number of CBEND plants that can be operated for grid infeeding in the communal areas.

Ideally, CBEND plants should be placed on farms that provide easy access to main roads and other facilities. As vast areas in rural Namibia exist long distances from main roads, schools and clinics, this may be a constraint to the number of farms that can accommodate CBEND workers. Figure 5.7 gives some indication of the areas that are closest to infrastructure and local services.

[4] Unpublished data reported in *Die Republikein* 8th February 2010.

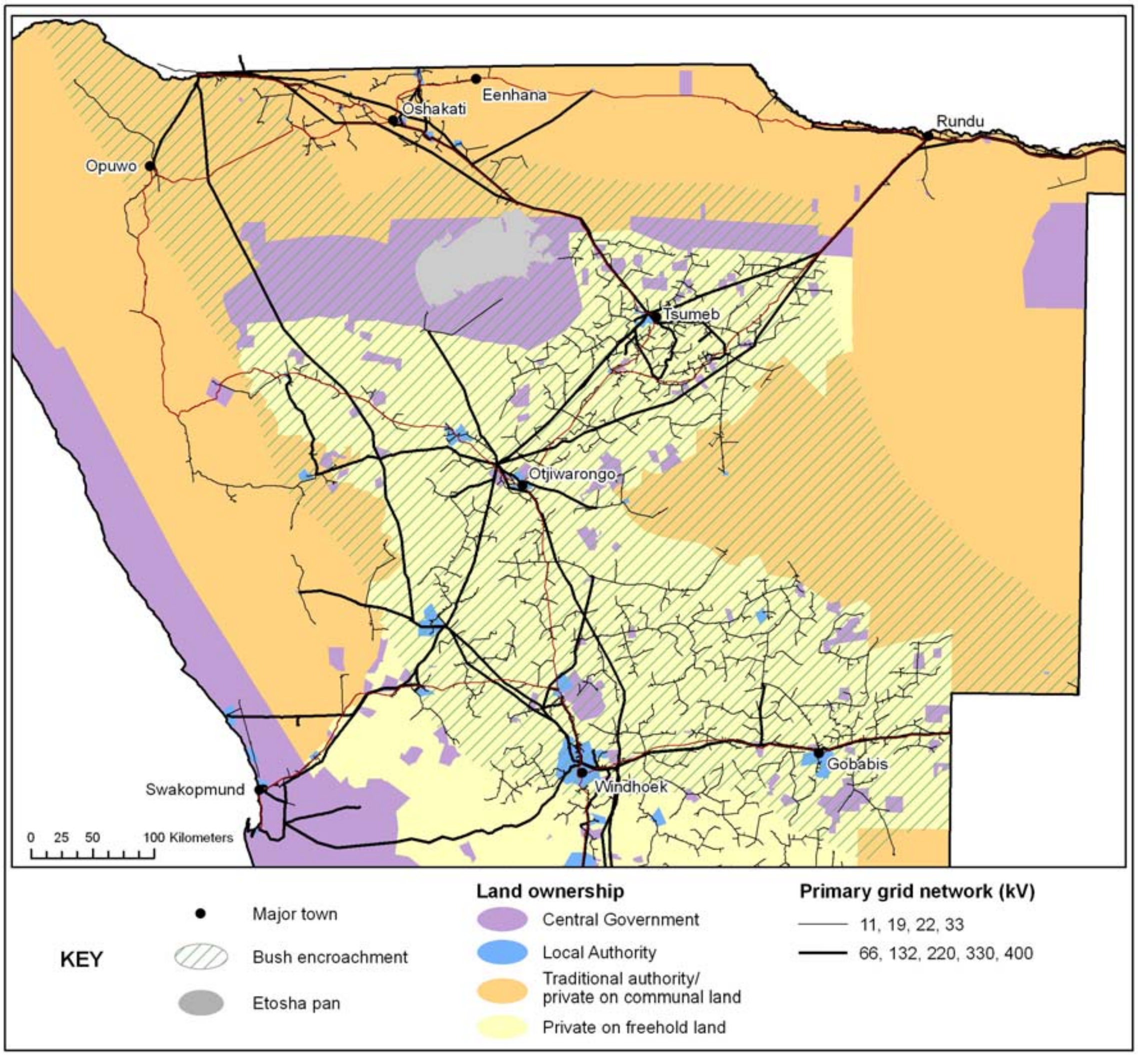


Figure 5.6 Bush encroachment in northern Namibia mapped against communal and freehold farming areas and the network of powerlines that can accept CBEND infeeding.

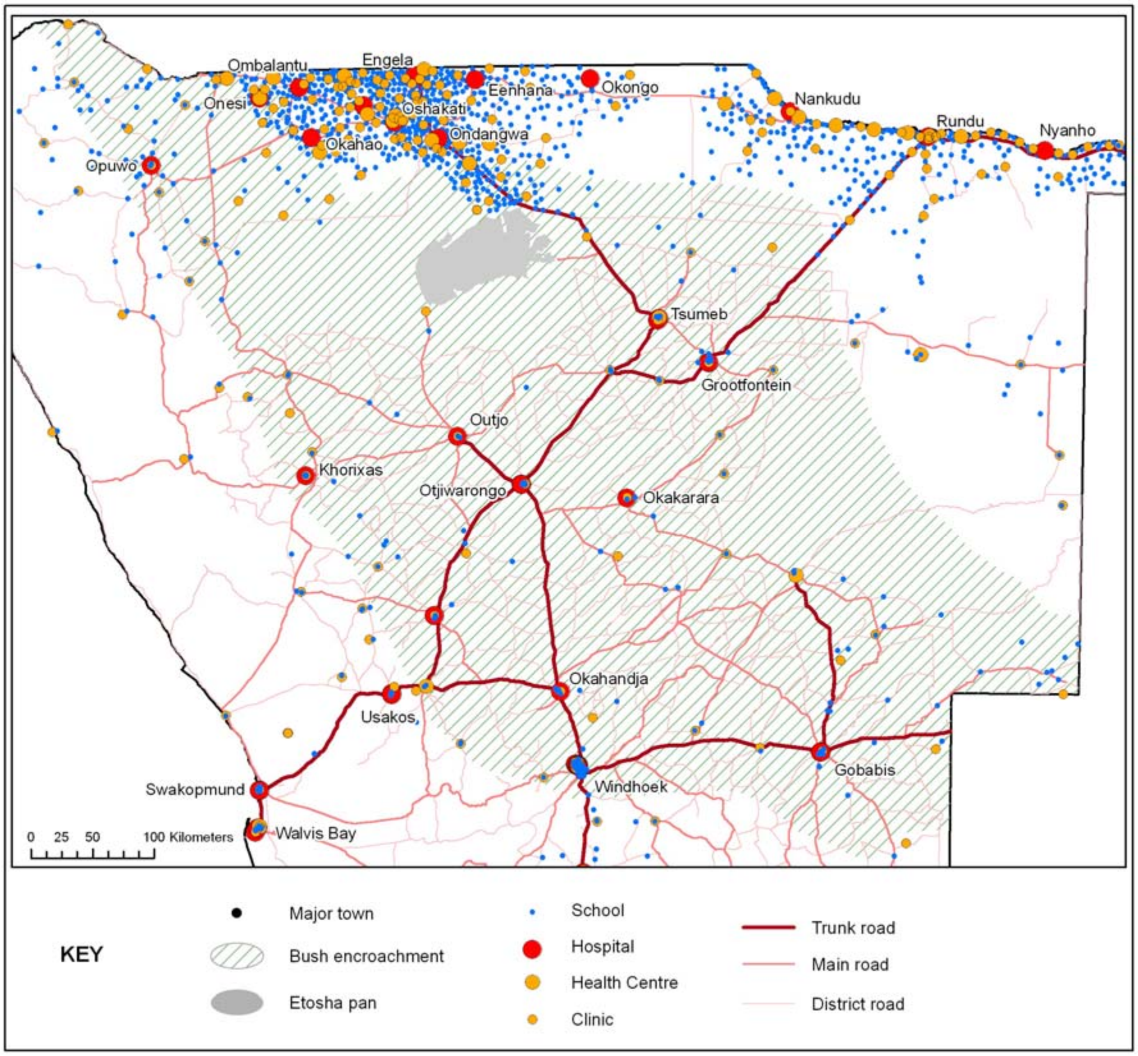


Figure 5.7 Bush encroachment in northern Namibia mapped against road, school and health services.

5.2.7 Resettlement farms as a CBEND target

A potential focus for replicated CBEND plants is on resettlement farms within bush encroached areas (Figure 5.8).

Between 1992 and 2002, 209 commercial farms and an estimated 9,138 people were resettled through the MLR's resettlement programme (Harring and Odendaal 2007) and a further 625 farms (covering 3.5 million hectares) had been acquired through the Affirmative Action Loan Scheme (LAC 2007). The recipients of the former do not have title over the land upon which they have been resettled, although AALS farmers do. In addition to resettlements on commercial farms, 27 942 people were resettled by the MLR on communal land that has been identified as 'underutilised' (LAC 2007).

Although resettlement farmers have only a 99-year lease on their land, and not full title, the National Resettlement Policy gives the directive that the Resettlement Policy should "enhance the welfare of the people through improvement of productivity". Specifically, its objectives include:

- "to bring farmers into the mainstream of the Namibian economy by producing for the open market …", and
- "to create employment through farming and other income generating activities."

The leasehold status does therefore not preclude them from harvesting bush on resettlement farms, and permits are indeed issued by the Directorate of Forestry for bush or wood harvesting on resettlement farms just as they are on any freehold or communal land.

Socio-economic problems appear to be rife on many of the MLR's resettlement project farms and resettled communities have repeatedly been described as poor/extremely poor and vulnerable. Most of these farms occur on land that was once freehold and some (e.g. *Julianna* in Otjozondjupa) have reduced land-use options as a result of severe bush encroachment (NPC 2007a). Redistributing a bush-encroached farm to several settlers exacerbates land degradation and undermines economic viability (LAC 2007).

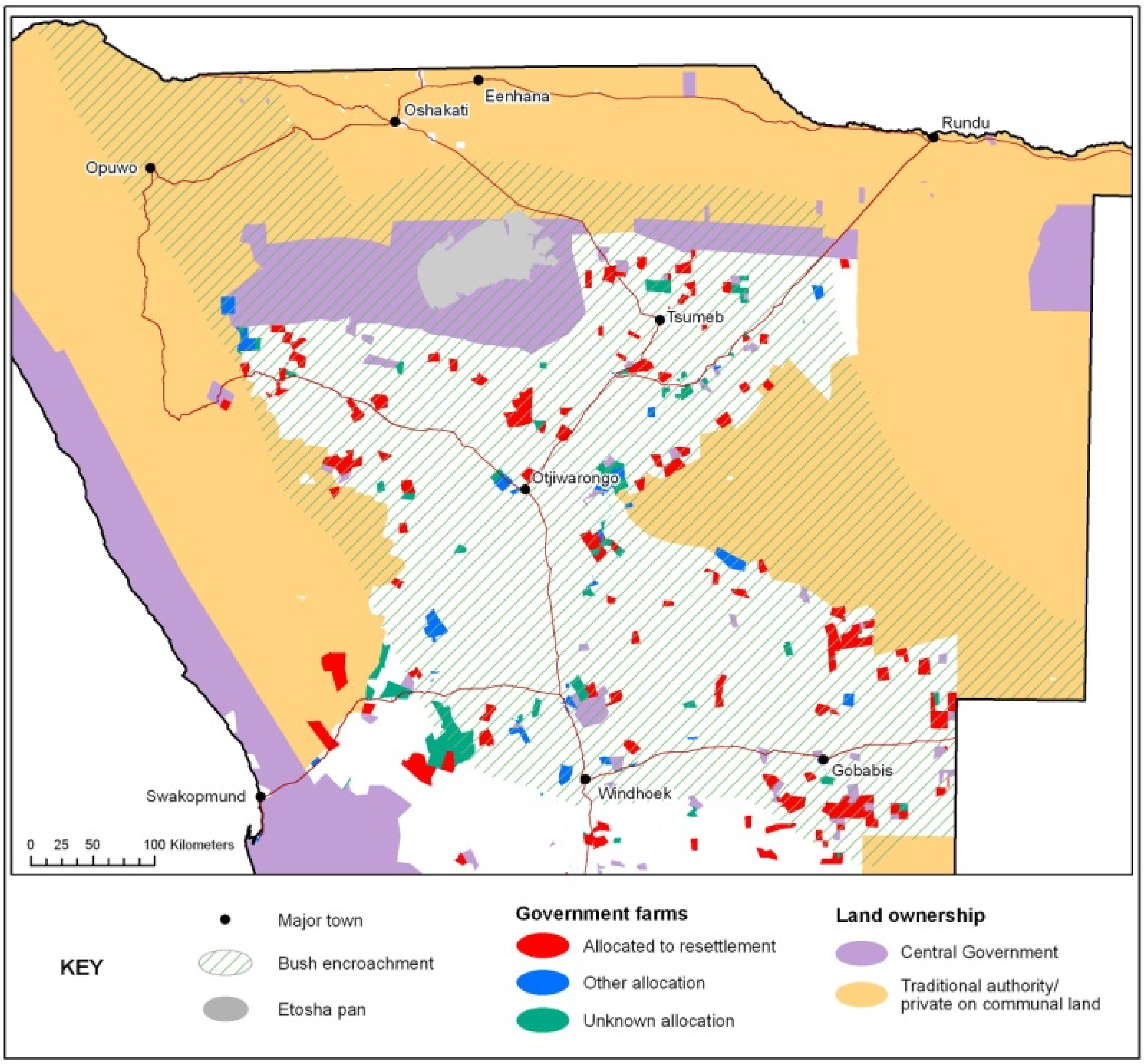


Figure 5.8 Bush encroachment in northern Namibia mapped against Government-owned resettlement farms.

Some of the problems that have arisen on these farms are documented as follows (Harring and Odendaal 2002; Harring and Odendaal 2007; DRFN 2007; Cloete 2009):

- A lack of governance on many resettled farms has resulted in many socio-economic problems.
- Most resettlement project clerks and managers have limited technical or managerial skills. Very few have a background in agriculture.
- Ethnic tensions occur on many farms where the beneficiaries are from different ethnic groups.
- Many resettled people on project farms feel isolated and cut-off from mainstream society. Poor access to transport and the remoteness of the farms limits opportunities for marketing produce and the chances of beneficiaries being able to pursue a supplemental income.
- Many resettled families suffer food insecurity and are dependent either upon the pensioners amongst them or upon government aid (food for work schemes or drought relief) for survival. This creates a culture of dependency.
- Poverty on resettled farms is accompanied by high levels of alcohol abuse, violence and crime. Distance from police stations means that security can become a major problem.
- Most resettled farmers have no access to electricity or other energy sources and communities depend heavily on wood for cooking fuel.
- In many cases access to a reliable water source is not secure. Inadequate water infrastructure and /or knowledge of fixing water pumps is reported from many farms, as is a lack of post-settlement financial support.

Elias Hoebeb, one of two farm laborers allocated 1,391 ha on an expropriated farm 40 km east of Windhoek (Khomas Region), summed up the circumstances on the average resettled farm when he said "*We have no money, no fuel to get the water pump running and no farming implements, let alone a vehicle - some of us now work on neighbouring farms to earn some cash*" (IRIN, 2006).

The above descriptions would give the impression that resettlement farms are an obvious target for the labour creation that CBEND proposes, and many resettlement farms are situated in Namibia's most bush encroached areas. However, it was mentioned at the CBEND SEA workshop (see Section 6.2.5) that although many resettled farmers are struggling, they may be unwilling to engage in the type of manual bush clearing activities that CBEND involves.

Plate 5.1: Many resettlement farms are densely bush encroached. The CBEND concept represents an opportunity to provide some of these communities with employment to harvest bush and improve their livestock production.

5.3 Electricity baseline

One of the most important criteria for the establishment of a CBEND-like project is the proximity to an electricity distribution network. Grid connection can be done onto most of the 11, 22 and 33 kV distribution network. The current distribution network covers the most densely populated parts of the northern communal areas as well as most of the freehold farming areas in central Namibia (Figure 5.6).

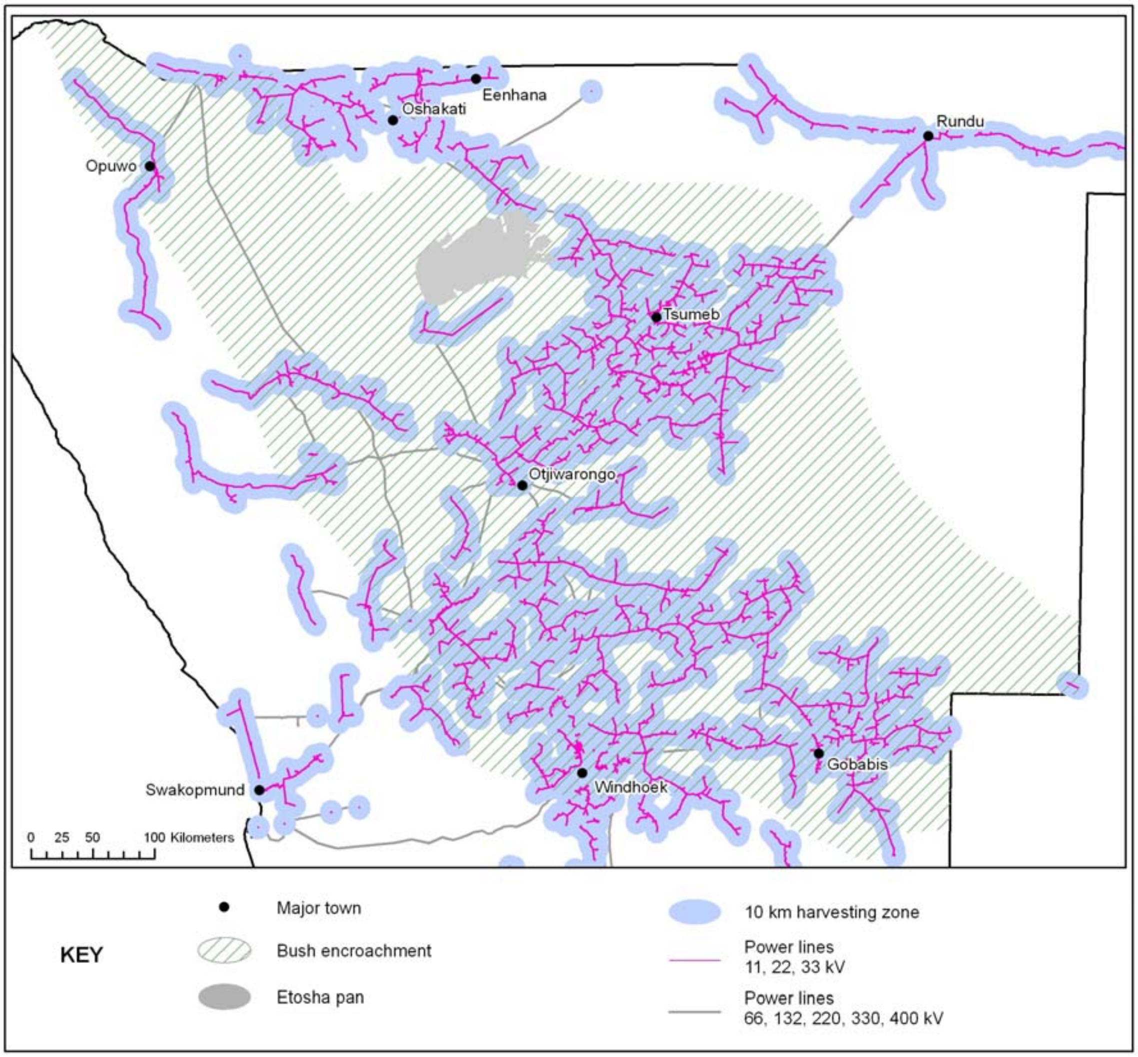


Figure 5.9 Namibia's northern bush encroached areas with the extent of 11, 22 and 33 kV distribution lines, and a 10 km bush harvesting zone on each side of the lines

Although it appears that approximately 40% of the encroached area is within 10 km of a distribution line, NamPower noted that the dynamics of each reticulation system (which is the domain of the REDs) is unique in terms of load factor and efficiency. Any potential CBEND generator should therefore consult with the RED in order to optimize location of the plant and also the dynamics of the relevant reticulation.

From NamPower's perspective, generators should ideally be located closer to, rather than further from, the substations to minimize the impact of load factor on the interconnection.

5.4 Laws, Policies and Institutions

Environmental legislation is not a distinct body of law but provisions that are of relevance are included under many different laws, administered by different Ministries. The most relevant laws and policies are summarised in this section.

5.4.1 Legislative Framework

The Constitution of Namibia:

The Constitution is the highest law of the land and the foundation on which all laws and policies are developed. Article 95(1) commits the state to actively promote and maintain the welfare of the people by adopting policies aimed at the "…*maintenance of ecosystems, essential ecological processes and biological diversity of Namibia and utilization of living natural resources on a sustainable basis for the benefit of all Namibians, both present and future….*."

Environmental Management Act 7 of 2007

This act describes various rights and obligations that pertain to citizens and the Government. It sets out 13 principles, including: -

- Renewable resources shall be utilized on a sustainable basis for the benefit of current and future generations of Namibians,
- Community involvement in natural resource management and sharing in the resulting benefits shall be promoted and facilitated,
- The precautionary principle and the principle of preventative action shall be applied,
- A requirement for prior environmental assessment, and
- Namibia's movable and immovable cultural and natural heritage, including its biodiversity, shall be protected and respected for the benefit of current and future generations.

The Act has been gazetted but is not yet in force.

The Forest Act No 12 of 2001

This Act is highly relevant to any bush clearing activities, and it makes specific provision in regard to permitting requirements. The Act is aimed at the sustainable management of forests, and clearly states: "the purpose for which forest resources are managed and developed … is to conserve soil and water resources, maintain biological diversity…" Although much of the Act relates to classified forests, the above provisions apply not only to classified forests but also to "any piece of land".

Certain restrictions limit the harvesting of forest produce, as follows:
"Unless approval has been given by the Director, no person shall: -
… clear the vegetation on more than 15 hectares on any piece of land or several pieces of land situated in the same locality which has predominantly woody vegetation; or

… cut or remove more than 500 cubic metres of forest produce from any piece of land in a period of one year. “
Before giving approval the Director must take into consideration an Environmental Assessment Report.

Section 16(1) provides that: “The Director may enter into a forest management agreement with any person or institution for the creation of a forest management area on land which does not form part of a classified forest, but which land is owned by that person or institution or can be legally used by that person or institution.”

Section 22 is also very important in restricting harvesting:
(1) Unless otherwise authorized by this Act, or by a licence issued under subsection (3), no person shall … cut destroy or remove -

> (a) vegetation which is on a sand dune or drifting sand or on a gulley ... or
> (b) any living tree, bush or shrub growing within 100 metres of a river, stream or watercourse.

This applies to all vegetation, including encroacher bush species.

Permits are granted by the Directorate of Forestry for harvesting wood, and/or transport and exporting of wood. Harvesting permits are valid for 6 months, and are subject to inspection of the areas that have been or will be harvested. Transport is sometimes included in the harvesting permit, but for firewood gathering purposes is more typically granted for only 2 weeks. Permitting issues need to be clarified so that permitting for harvesting and transport to the CBEND plant is consistently granted for 6 month periods.

A number of tree species are protected under the Act. This is in addition to species that are protected under the Nature Conservation Ordinance. A list of protected species is provided in Appendix D. It includes mopane (*Colophospermum mopane*) which, although protected is also an encroacher and one of the CBEND targets for harvesting (and is actively harvested for charcoal and firewood). This also needs to be resolved in the legislation.

Nature Conservation Ordinance 4 of 1975, and Regulations relating to nature conservation Published under GN 240 of 1976 (GG 3356 of 25 August 1976)

No person shall without a permit from the Minister of Environment & Tourism, damage, destroy or transport any protected plant. A list of protected species is provided in Appendix D.

The Soil Conservation Act No 76 of 1969 & the Soil Conservation Amendment Act No38 of 1971

This Act makes provision for the prevention and control of soil erosion and the protection, improvement and conservation of soil, vegetation and water supply sources and resources.

The Minister of Agriculture, Water & Forestry may issue directives to land owners in respect of, amongst others:

- the prevention of erosion, the denudation, disturbance or drainage of land; and
- any other disturbance of the soil which creates or may create conditions which cause or may cause any form of erosion or pollution of water by silt or drift sand.

Water Act 54 of 1956

It is an offence to pollute any water, including dry water courses and groundwater, in such a way as to render it less fit for the purposes for which it is or could be ordinarily used by other persons. The polluter is also liable for clean up costs.

National Heritage act 27 of 2004

This Act provides for the protection of places and objects of heritage significance, including any remains of human habitat that are more than 50 years old, and rock art. “Heritage significance” means aesthetic, archaeological, architectural, cultural, historical, scientific or local significance; i.e. items such as ruins, archaeological artefacts, rock art, military objects, meteorites or possibly even fossils.

Such items or sites containing them shall not be disturbed and no such material shall be moved, removed or sold. Should any such items or places be found they have to be reported immediately to the National Heritage Council.

Labour Act 11 of 2007

Occupational Health and Safety regulations have not been promulgated under the new Act but the old regulations on Health and Safety are still in force. These would be applicable, for example relating to the following:

- Wearing suitable boots to protect against thorns,
- Wearing goggles or visors to protect eyes,
- Wearing construction helmets as protection against flying chips or wood or stone,
- Wearing canvas or other suitable clothes and gloves as protection against thorns,
- Suitable protection measures and emergency procedures at the plant.

Electricity Act of 2007

The Electricity Act of 2007 incorporates the needs of the energy sector into a single document, prohibiting the generation, trading, transmitting, supplying, distributing, importing and exporting of electricity without a license, with the exception of power plants with a capacity of less than 500kVA (for non-commercial use).

5.4.2 Policy Framework

The **National Development Plan** - and **Vision 2030** are relevant in broad terms. They mention sustainable use of woodland and forest resources. Vision 2030 also mentions “alien invasive trees” as a threat to biodiversity and water resources.

The **National Forest Policy** (1992) was introduced to combat the process of desertification by promoting the sustainable and equitable development of natural forest resources.

The guiding policy documents for forestry development in Namibia are the following:

- The **Namibia Forestry Strategic Plan** aims at the protection and sustainable utilization of natural forests, with the intended benefits of conservation of ecosystems, increased agricultural productivity, soil and water conservation, poverty alleviation and equitable development, protection of biodiversity and preventing climate change. It recognizes the need for institutional capacity building, research and information management. Although establishing a number of relevant principles, the plan does not deal specifically with bush encroachment.

- The **Namibia Forest Development Policy** contains poverty alleviation measures aimed at, amongst other things, increasing livestock production, small and medium scale manufacturing enterprises based on wood – particularly non-forest wood, conservation of wildlife habitat as a basis for tourism, sustainable rural economies. It emphasizes biodiversity conservation by empowering farmers to manage forest resources sustainably, and innovative land-use strategies within multiple use conservation areas. In commercial areas the policy encourages debushing for charcoal production in order to enhance rangeland productivity. Other than that, the policy does not deal specifically with bush encroachment.

- The **National Agricultural Policy** recognizes the problem of bush encroachment, and desertification, and environmental degradation caused by the destruction of forest cover, soil erosion, overgrazing and bush encroachment. The policy intends to "establish mechanisms to support farmers in combating bush encroachment effectively over the short and long term". It contains policy statements that, while not dealing directly with the problem of bush, nevertheless have a bearing on options for removal and prevention of bush encroachment.

- The **Draft Bush Encroachment Policy of Namibia** has not yet been approved. It is the only policy that provides practical guidelines for the management of encroacher bush. It also analyses some of the key policy issues that are inhibiting effective management of the problem. It recommends amendments to the provisions of the Forest Act and the Soil Conservation Act to deal specifically with the management of encroacher bush. The draft Policy identifies some shortcomings in the existing policies, including the current policy on the use of fires for veld management. Fire should be permitted as an important management tool in grasslands, helping to prevent them from becoming re-encroached.

The **National Guidelines on Fires and Fire Management** provide the framework for the management of fires within Namibia, a possible tool for combating bush encroachment. This is dependent on woodland management being in the scope of forestry legislation and policy.

The **National Drought Policy and Strategy** proposes to do away with subsidies for fodder and forage during drought because these subsidies encourage farmers to retain excessive numbers of livestock. Instead incentives will be used to encourage farmers to market their livestock in times of drought. Importantly, only those farmers who have implemented sustainable farm management practices are supposed to qualify for drought aid.

The **Policy for the Conservation of Biotic Diversity and Habitat Protection (1994)** requires that all development must be sustainable and must be evaluated at an appropriate level by means of environmental assessment procedures. Monitoring, inventories, education and extension, and systematic and biogeographical studies are needed to define the conservation status of all Namibian flora and fauna, and to protect biodiversity of habitat and species.

The **Environmental Assessment Policy (1995)** is still applicable as the Environmental Management Act is not yet in force. This policy deals with the requirements for Environmental Impact Assessments, and the principles underpinning sound environmental management in

Namibia. For example of particular relevance, the policy places a high priority on, amongst others:

- Maintaining ecosystems …in particular those important for water supply, food production, … tourism, and sustainable development…,
- … optimum sustainable yield….
- …maintaining representatives examples of natural habitats…,
- … maintaining maximum biological diversity by ensuring the survival and … conservation in their natural habitat of all species of flora and fauna.

Under Namibia's Environmental Assessment Policy, the environmental impacts of any development activity should be considered and thoroughly researched; lessening impacts where possible and making provision for unavoidable negative effects. Activities should be planned to address all levels of the development, from planning to decommissioning.

National Land Policy, National Resettlement Policy, Agricultural (Commercial) Land Reform Act 1995, Land Tax and Communal Land Reform Act 2002

Within these policies, the relevant factors include the need for land to be used sustainably, natural resources should be utilized efficiently, levying of land tax on unimproved land, land size allocation and the allocation of non-freehold area rights to Traditional Authorities.

Problems arise in that in many of the policies and guidelines have not been put in place to dictate how land resources should be used sustainably, leading to possible overgrazing and bush encroachment. Land tax can put extra strain on an already financially burdened industry, encouraging farmers to increase livestock thereby increasing pressure on grazing land.

The **Poverty Reduction Strategy for Namibia** was approved by Cabinet in 1998, and differentiates between a long-term goal to alleviate poverty and a number of short-term options to generate income. The strategy moves away from agricultural endeavours, as it is believed that agriculture will not be able to provide a sustainable basis for prosperity. It is also assumed that in 25yrs from now, the majority of the population will reside in urban centres; therefore (as long-term goals) it is necessary to develop Namibia into a manufacturing and transport hub and investment in education and health services.

For the short term objective of generating income, the strategy focuses on the promotion of agriculture, tourism and small-and-medium-scale enterprises. For the purposes of this project, the agricultural sector is envisaged to increase productivity and production through agricultural extension, new crops and more efficient water use.

The strategy also promotes the strengthening of Namibia's safety net through labour intensive public-works and the use of grant-based transfers. Support should be given to the various ministries, including the Ministry of Works, Transport and Communication and of Agriculture, Water and Rural Development.

The Namibian White Paper on Energy Policy (1998) stipulates 6 goals for the energy providers in Namibia; effective governance, security and supply, social upliftment, investment and growth economic competitiveness and efficiency and sustainability. The White Paper emphasizes the development of renewable energy resources.

5.4.3 International Conventions and Treaties

Namibia is a signatory to a number of international treaties and conventions, and must therefore comply with these.

The **Convention on Biological Diversity (1992)** has the objectives: -

- The conservation of biological diversity,
- The sustainable use of biological resources, and
- The fair and equitable sharing of the benefits arising out of the use of genetic resources.

The object of the **United Nations Framework Convention on Climate Change (1992)** is to achieve stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous human induced climate change ... to ensure that food production is not threatened ... and to enable economic development to proceed in a sustainable way.

The **Kyoto Protocol on Climate Change (1998)** provides for the possibility of a project earning Carbon Credits. The process is very expensive and cumbersome, and was agreed during the SEA workshop that it is probably not worthwhile for CBEND or replication projects.

5.4.4 Policies and regulations specific to electricity generation

5.4.4.1 IPP and Investment Market Framework[5]

In terms of Section 17 of the Electricity Act (Duty to obtain a license), no person may establish or carry on generation, transmission, distribution, supply, import or export electricity unless such person holds a license. As part of its mandate, the ECB makes recommendations to the Minister of Mines and Energy with regard to the issue, transfer, amendment, renewal and cancellation of licenses.

The primary objective of the IPP guidelines is to assist potential new investors in the electricity generation sector of Namibia to acquire a license, through clarifying the procedural and information requirements as well as the license evaluation process (Table 5.4). The ECB and NamPower are currently streamlining the framework for IPP processes, so the licensing procedures might change.

Table 5.4 Information and regulatory flows for Project Agreements (ECB 2009).
L - Lead; **S** - Secondary; **N** - No Role

Small IPPs	**ECB**	**NamPower**	**RED**
Technical & Safety	**S**	**L**	**S**
Sale-Purchase	**S**	**N**	**L**
Tariff	**L**	**N**	**S**
Physical Supply	**S**	**N**	**L**
Delivery & Acceptance of Output	**S**	**N**	**L**
Indemnity	**L**	**N**	**S**
Dispute Resolution	**L**	**N**	**S**

[5] The final report is available on the ECB website, www.ecb.org.na under “General Documents”

5.4.4.2 *Grid Code*

The term Grid Code refers to a set of documents that legally establishes technical and other requirements for the connection to and use of an electrical system by parties other than the one owning an electric utility in a manner that will ensure reliable, efficient, and safe operation. It provides the rules and procedures that enable the power system to be planned and operated reliably.

This Code contains a set of connection conditions for generators, distributors and end-use customers, and the standards used to plan and develop the Transmission System.

The Grid Code documents are:

- The Preamble,
- The Network Code,
- The System Operation Code,
- The Metering Code,
- The Information Exchange Code, and
- The Governance Code.

In planning the generation plant and its operational procedures, cognisance must be taken of the various requirements stipulated in the Code.

5.4.4.3 *Generation License*

Any potential generator must apply for a Generation Licence from the ECB (as mentioned in paragraph 5.4.4.1). This process can be summarized as shown in Figure 5.10.

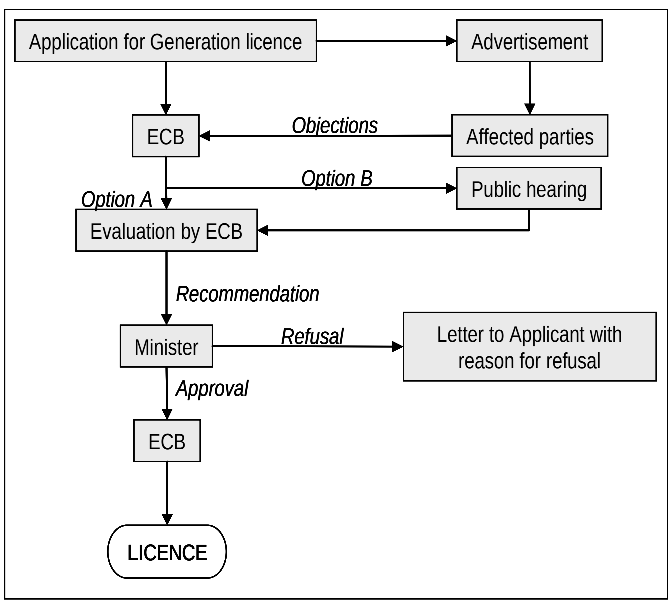


Figure 5.10 Flow diagram of Generation Licence application process (ECB 2009).

5.4.4.4 *Power Purchase Agreement (PPA)*

If the Generator plans to feed electricity into the NamPower Transmission Grid, the Generator must have a Power Purchase Agreement (PPA) signed with NamPower. This process is illustrated in Figure 5.11 below:

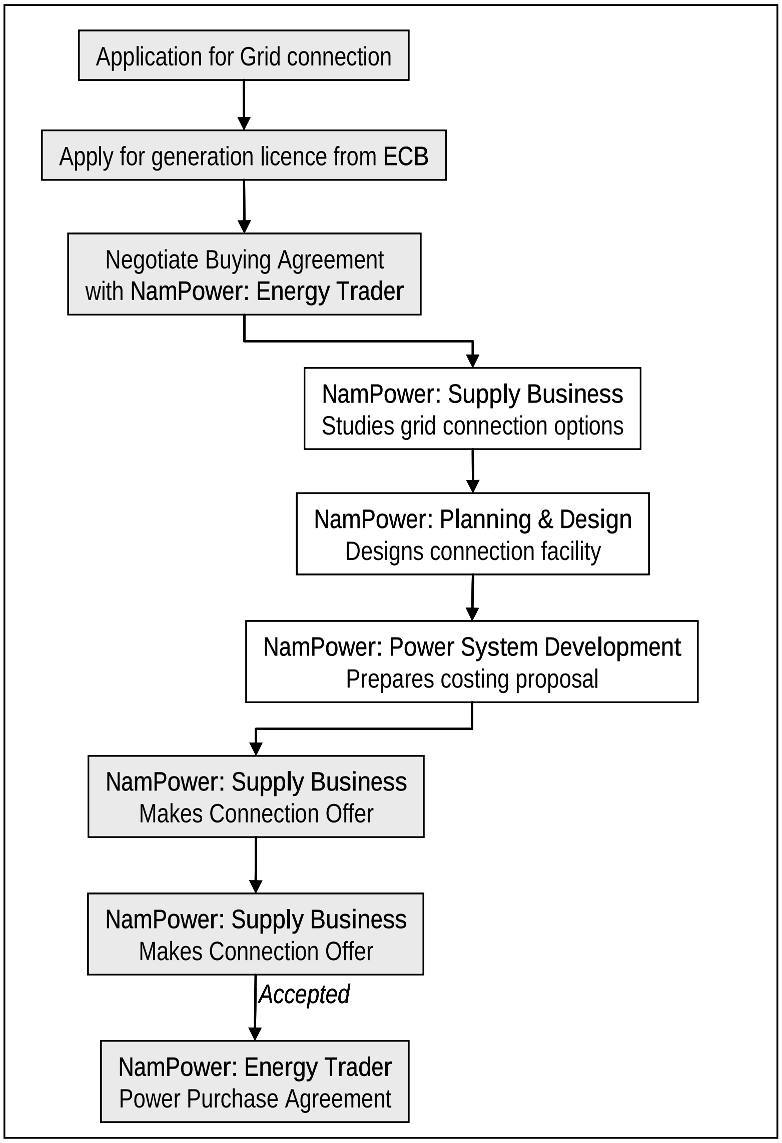


Figure 5.11 Diagram showing the process for obtaining a PPA with NamPower

Any prospective Generator must approach the "Energy Trader" of NamPower to negotiate a buying agreement (eventually a Power Purchase Agreement). Once the "Energy Trader" approves the proposal, the "Supply Business" department investigates the options of connecting the Generator into the NamPower Transmission Grid (NPTG). At the same time the "Planning and Design" department designs the proposed connection facility (with metering and circuit breaker) that will be located at the Generator. The "Power System Development" department then does the costing to enable "Supply Business" to give a quote to the Generator. The Generator is responsible for all design and equipment to do synchronizing and protection (i.e. to get the generator's power synchronized with the grid power and that breakers open when they should etc.) at the proposed connection facility. Finally a Power Purchase Agreement and Connection Agreement are signed between the relevant parties; NamPower, the RED and the Generator.

6 STAKEHOLDER CONCERNS

6.1 Bush encroachment, rangeland and ‘bush farming’ concerns

During consultations with farmers the following issues were raised as concerns.

6.1.1 Adverse impacts of bush encroachment on livestock farming

Bush encroachment has impacted badly on the cattle industry, reducing numbers greatly. This affects farmers and the whole beef industry, which is operating below capacity. From a cattle farmer’s perspective, beef production is the ultimate goal, and bush harvesting is a means to that end. However, bush clearing - and aftercare to sustain the benefits of clearing - costs money.

Some farmers do not see the need to debush, since they can make an adequate living without having to spend money on it. It is easier to do this now as farming incomes can be supplemented by wildlife and tourism, which is not severely impacted by encroachment. Such farmers might want the bush encroachment problem to be solved, but are not willing to invest time or money doing so. They might respond to some kinds of subsidization to persuade them to debush.

One farmer expressed concern that restoring land to more productive savanna may make the farm too attractive, so that it might be targeted for expropriation and redistribution.

The Cheetah Conservation Foundation (CCF) expressed the opinion that bush can be thinned to improve beef production and harvested sustainably to maintain a stream of income from bush. The first pass over a densely bushed area is the most profitable for income from bush, then subsequent harvesting of the regrowth is less so but it will still bring in some money.

There were two schools of thought amongst interviewed farmers:

- The first seeks to debush in order to restore open savanna, with a few scattered trees, for the sake of ecological integrity. It seeks to maintain open condition so that pastures for cattle are optimized. In this view good rangeland management is the prime concern, and generating money from charcoal or CBEND should just be a means to that goal. Proponents of this view maintain that the second approach does not manage rangelands properly or help to optimize biodiversity (especially due to decreased soil moisture in bush encroached areas).

- The second seeks to harvest selectively so that bush industries (charcoal, firewood, CBEND) are sustained. It emphasizes selective harvesting so that income sources from bush are sustained.

The SEA feedback workshop recognised that these two schools are not mutually exclusive: one can blend the two to support both cattle farming and the CBEND concept. The point was made that combating bush encroachment is prohibitively expensive for a relatively small farm (less than about 6,000 ha), and some form of external support is required. Such farmers could go into an agreement about harvesting bush on their farm for a nearby CBEND plant, and thus achieve the rangeland improvement as well as sustainable bush harvesting that is desired.

The Rangeland Management Strategy sets out eight principles of good rangeland management. These should be the guiding principles that bush thinning for CBEND adheres to. For instance, an important feature of rangeland management is to retain moisture in the soil. This is done by encouraging perennial grasses, promoting buildup of mulch, and getting more ground cover. Some people thought that these issues are not adequately considered by charcoal farmers.

Some farmers felt that increased beef production should be enough incentive to debush. One farmer claimed that he could double his beef production from a densely bushed area by chemical clearing, over 2-3 years. Others stated that they could recover the cost of chemical clearing within 4-6 years simply by the improvement in beef production. This is usually too long for an emerging farmer to wait, so there should be incentives (e.g. soft loans) to debush with delayed repayment. Using this and other techniques (e.g. rotational grazing), even smallish farms (~5,000 ha) could become financially viable for beef again.

6.1.2 Adverse impacts of bush encroachment on rangeland integrity

Groundwater levels were reported to be dropping on some farms, which was thought to probably be the result of bush encroachment.

A few farmers made the point that excessive bush clearing can reduce soil fertility, especially on sandy or silty soils. Some opinions were given on the recovery of biodiversity on well managed rangelands.

6.1.3 Opinions towards the CBEND concept

Most farmers considered the CBEND concept to be good. No farmers were opposed to it and most agreed that there is enough bush to keep many CBEND-like plants going. Many voiced concern that high capital costs for startup would prevent it rolling out without donor assistance.

The Cheetah Conservation Foundation (CCF) said that 250 kW generating plants were probably too big to be useful to most farmers, and create the limitation that the plant must be near a powerline so that power could be sold. Smaller units that could create a farm-based mini-grid would probably be more useful and more financially achievable. Willem Enslin (past Charcoal Producers Association chairperson) agreed.

One farmer raised doubt over CBEND viability on the basis of the cost of transporting raw material to the plant.

Harvesters might pose competition with charcoal harvesters so the total amount of charcoal harvesting may decrease. However, less production could mean increased price, so it does not necessarily impact on the charcoal industry.

CCF was concerned that the gasifiers they saw in India were very fussy about the dimensions of sticks being fed into the machine. If this is an important factor for operating the machine, it might undermine the viability due to more labour required, and due to competition with charcoalers. Regarding environmental impacts, there is very little pollution, very little effluent, some waste heat, but all very minor. Gasification is inherently a good concept because the technology is efficient. CBEND eill be able to use 4 times more wood than if burning for charcoal i.e. it is a much more efficient use of the bush resource.

6.2 Biophysical concerns

Some farmers and other parties interested in CBEND expressed the concern that harvesting of encroacher bush, as practiced by the charcoal industry, is removing many old, large, non-encroacher trees, as well as protected trees. CBEND replication adds to this concern because it will increase the likelihood of this illegal activity. The charcoal industry and the Directorate of Forestry are both accused of allowing this situation.

6.3 Socio-economic concerns regarding bush cutters in the charcoal industry

There are an estimated 4,800 charcoal workers/cutters in Namibia (pers. comm. Muduva and Dieckmann 2010). Valuable insight for the CBEND concept can be gained by investigating the social and micro-economic issues that impact upon these workers. Some of the preliminary, as yet unpublished, findings of the LAC's *Land, Environment and Development Project*[6] are presented below (Sections 6.2.1 – 6.2.3) (pers. comms. Muduva and Dieckman 2010):

6.3.1 Demographics and earnings

- A total of 51 charcoal workers (all men) were interviewed, stationed on commercial farms in the Outjo, Otjiwarongo and Grootfontein districts of Kunene and Otjozondjupa. They included people from Ohangwena, Oshikoto, Oshana, Omusati and Kunene, but the majority of bush cutters come from Kavango.
- Most of the charcoal workers have limited levels of education, varying experience in charcoal production, and few skills. Cutters range in age from 17 to over 60.
- Cutting and burning is done almost exclusively by men. Women sometimes help to gather the wood and pack the charcoal.
- The charcoal workers are self-employed. They sell their charcoal to the farmers (the charcoal producers) and are highly dependent on these buyers for their income and well-being. Because most farmers are unwilling to employ the cutters formally, and very few draw up contracts with these workers, the cutters do not benefit from social security nor are they protected by Namibia's labour laws.
- The cutters are paid per tonne. The price is not fixed and varies from N$300 to N$500 per tonne of charcoal. Pay-out is irregular and depends on when the farmer arrives to collect the charcoal. Workers sometimes go longer than 6 weeks without remittance.
- A hard working charcoal worker can cut enough wood to produce up to 2 tonnes per week (earning an estimated N$ 2,600 – N$ 4,300 per month which is considerably higher than the minimum wage) while others produce only 0.5 tonnes in the same period.
- One constraint to the amount of bush that can be cleared by a cutter (apart from motivation and techniques used) is the availability and quality of trees on the farm.
- Expansion of the charcoal industry is expected to continue. While almost 5,000 people are employed in this sector at present, the LAC study suggests that the number could go up to about 30,000 people in future.

6.3.2 Living conditions

- The charcoal workers work in isolated localities, very often far from shops, transport, clinics and other services.
- Most cutters live in extremely poor conditions – either in traditional huts or shelters made from plastic or zinc sheeting. Very few possess protective footwear or overalls.

[6] Regarding Namibia's charcoal workers, this research focuses on :- the legal framework as it applies to the charcoal industry, in particular with respect of labour issues; the current market, and environmental and economic sustainability of charcoal; working and living conditions, economic situation, social background and expressed needs of charcoal workers (shelter, wages, protective clothing, health issues, equipments, social security and contracts); and the role and the relationship of the various stakeholders in the charcoal sector e.g. the Farm Workers Union (NAFWU), NCPA, the relevant line Ministries.

- The living conditions of charcoal workers on resettlement farms are particularly severe. Due to transport constraints many do not receive food when they need it and have no means of getting to hospital if a medical emergency arises.
- Some cutters (an estimated 30%) bring their wives and families with them. For the majority that are not accompanied by their families, their lifestyle brings family instabilities and makes them vulnerable to STDs and alcohol abuse.
- Because of transport constraints and distances from shops most cutters buy their food on credit from the farmer. The LAC researchers are concerned that these labourers are highly vulnerable to exploitation in this regard. Some of the cutters say that they are sometimes left without payment after the credit for food has been deducted from the cost of the charcoal.
- Representatives from the Ministry of Labour and Social Welfare and Directorate of Forestry are supposed to visit farms where charcoal activities occur. The cutters report that they are unaware of any visits.

6.3.3 Charcoal workers' perceptions of their work

The cutter's regard their work as physically taxing and poorly paid. Although they can earn well if they work very hard it is unlikely that they would choose this work if they had other options. Some complain that the food they have to buy is expensive and that the farmers' remain unconcerned if they are sick or have injured themselves. Very few cutters stay with one farmer for many years.

6.3.4 Opinions of farmers to labour-intensive bush cutting

During the workshop discussions, some insights were gained regarding the farmers' perspective on migrant labour linked to the charcoal industry. In summary:-

- Few farmers welcome large numbers of migrant labourers onto their farms. They fear that if they do, they will be inviting stock theft, equipment theft, poaching, disruptions amongst their established staff, alcohol-related problems and security issues.
- The charcoal cutters are "restless" and if they hear of improved conditions on a neighbouring farm they move off from one day to the next – often taking equipment and protective clothing with them.
- Farmers sometimes spend a disproportionate amount of time on the recruitment of cutters (one farmer allegedly spent 2 months in 2009 just recruiting). Although men from Kavango are still most often employed, finding people willing to cut bush is becoming increasingly difficult. It was reported that resettlement farmers at Queen Sofia Resettlement Farm (near to the CBEND pilot plant at farm Pierre) were not willing to do bush-harvesting work.
- The formalisation of charcoal labourers as employees demands time, effort and considerable amounts of paperwork. It is uncertain whether most land owners will be prepared to do this, unless they are forced to.
- In the absence of strong incentives, most farmers are likely to choose charcoal production or other options over the CBEND initiative (Ian Galloway, pers comm.). This is because a CBEND plant will require a certain amount of capital investment and if farmers are forced to follow best practice options through the formal employment of workers (as laid down by the Labour Act), the financial costs and time spent on dealing with labour issues could be restrictive. However, if the CBEND concept *is* embraced, most farmers are likely to choose mechanical cutting methods over human labour (*ibid*).
- All farmers agreed that harvesters should be paid per unit area harvested, so that they are given an incentive to cut.

6.3.5 Availability of labour for CBEND operations

There was general agreement amongst interviewed farmers and workshop participants that rural residents are reluctant to do bush-cutting work. A Directorate of Forestry official reported that they find it very difficult to recruit workers to cut fire-breaks, and that although this work is remunerated, and there are people who could work and who want work, they do not offer themselves for this employment. He also reported that it is not uncommon for resettlement farmers to seek work in towns rather than do farm work. Another opinion voiced was that resettlement farmers do not wish to be farm workers, they want to be farmers (with a managerial rather than a labour role).

6.3.6 Complying with stipulations of the Labour Act

A farm labour specialist in the NAU (Giel Schoonbee) provided useful information and guidance with regard to the charcoal industry and similar issues that CBEND farmers would face.

The Labour Act stipulates conditions for labourers regarding overtime, meal times, leave, remuneration, severance pay etc, yet it is impossible for employers in the charcoal industry to comply with these due to the informal nature of the work. In this event an individual or a group with a common interest can apply for exemption from certain stipulations, so long as they have the consent of the employees. This is being done for the charcoal industry, with an agreement being negotiated between NAU, NNFU, trade unions and the government. The purpose of such an exemption is to run a system in which charcoal producers can follow certain formalised procedures in drawing up a contract with bush cutters that recognises the realities of the work, and choppers can get a proper job description and remuneration package based, through negotiation, on production.

In the case of CBEND replication, each IPP would have to register individually, but replication would mean that they could make representation to the Ministry of Labour as a class of employers in the same way that charcoal producers are doing. Alternatively, bush cutters could organise themselves into harvesting businesses (e.g. a 'CBEND Employers Organisation') which would have to register with the Ministry of Labour and apply for the exemptions from the Labour Act stipulations that the work required. Remuneration could be negotiated on the basis of production. Such an organisation would act as a labour hire company providing a service to the IPP.

Overall opinions during the workshop discussion, despite the NAU guidelines, was that the Labour Act is regarded as a disincentive for labour-intensive activities on farms, and that most farmers would be reluctant to establish CBEND operations because of the anticipated labour complications. There will need to be strong incentives for CBEND replication to overcome this reluctance.

6.3.7 Occupational health issues

Even though CBEND workers should automatically be assured of protective clothing, good nutrition and access to clean water and adequate sanitation facilities, there are still occupational health hazards linked to CBEND activities. Health hazards for CBEND staff include injuries such as cuts, stings and snake bites, lung/allergy problems from over-exposure to fine sawdust, and heat stress from the outdoor work or from working close to the gasifier.

Future CBEND managers should ensure that the Ministry of Health mobile clinics (1,150 are active throughout the country) (MoHSS 2008) make regular farm visits and that HIV/Aids education is conducted on a regular basis.

6.4 Concerns about the economics of CBEND

6.4.1 Subsidisation:

Certain farmers believe that government should provide incentives to make debushing more attractive, such as provide a guarantee to purchase wood that is chipped and pelleted for export, or give assistance with the high capital outlay of setting up a wood pellet export business. Many referred to the example of Meatco, which receives, processes and exports beef for farmers so that the farmers benefit from the marketing and high quality standards which Meatco is able to enforce. A bush and wood enterprise operating on the same principles would be able to facilitate the marketing of various wood products, could act as a local FSC certifier or controller of other standards, control price competition, and could be the mechanism for greater control of and incentives for bush clearing. It could also assist with maintaining good labour relations. Some farmers indicated that they would like GRN to facilitate wood businesses but not try to control the industry – e.g. by granting soft loans or grants.

Some farmers feel that the government should facilitate various incentives to combat and derive benefits from bush encroachment. For example, an AgriBank project to provide low interest rates for bush clearing initiatives would help, but AgriBank is apparently waiting for GRN to first put up the money.

Similar opinions were raised at the CBEND SEA workshop but participants agreed that an infeeding subsidy would be the cleanest and most efficient form of financial assistance to CBEND farmers, as it would reduce cash interactions and would be more easily audited. Subsidising labour or transport or other components of the operation would be vulnerable to corruption and would involve a greater administrative effort. These difficulties would be less likely if subsidization was targeted at the infeeding price that a CBEND operator receives.

Other governments internationally (e.g. Germany, UK) subsidise grid infeeding as an incentive to encourage decentralized renewable energy generation. Lessons learnt from those countries should be applied here to increase the awareness and popularity for grid infeeding by whatever means: solar, wind or CBEND. The point was made at the feedback workshop that, over a long period (say 20 years), any renewable energy solution is cheaper than non-renewables, and that subsidization helps renewable energies get over the main barrier of capital investment to get started.

6.4.2 FSC certification

Forestry Stewardship Council (FSC) certification is sought by many charcoal producers as a higher price can be achieved for FSC certified charcoal overseas. While it is not mandatory, the market almost forces producers to follow this route since overseas consumers are becoming more fussy about ‘green energy’ (pers. comm. Galloway 2010), and the FSC label provides proof that the wood was harvested from sustainable sources.

FSC certification involves a lot of extra administration, but the farmers who follow that route claimed that is was worth it financially. Regular inspections are done to ensure that harvesting for FSC-certified charcoal complies with FSC standards. Four inspections per year from local inspectors, once per year from Jumbo, once every 5 years from overseas FSC representatives. Some farmers were critical of the FSC system, saying that it has good intentions, but not enough inspectors to enforce its conditions. Their opinion was that charcoal production is not adequately regulated to ensure that wood harvesting is done according to proper sustainability principles.

The FSC issue is not directly applicable to the CBEND concept since it will not have any jurisdiction over wood harvested for electricity generation. But the fact that CBEND operations are likely to be linked to charcoal production means that, for the charcoal producer that seeks FSC certification, bush harvesting will have to follow FSC guidelines. The overall concensus was that FSC certification is a good target to aim for but should not be enforced on farmers who are starting with charcoal production, because of the extra cost in administration and time.

6.5 Concerns about the regulatory framework and GRN capacity

6.5.1 Enforcement of regulations

Farmers recognize the need to comply with the law, especially the Forest Act 12 of 2001 and Nature Conservation Ordinance. Some feel that the use of aerially applied chemicals is not acceptable as it cannot be selective and kills protected species. Even hand applied chemicals may kill non-target trees that have extensive root systems.

Various people have, over the years, complained that charcoal production is not properly focused on combating bush encroachment, but that it is concerned only with obtaining the best wood for charcoal production i.e. large trees, not necessarily encroachers. This concern is now directed towards CBEND too, which will increase the market for wood cutting and therefore increase the exploitation of the 'wrong' tree species.

Ian Galloway (manager of Jumbo Charcoal) responded at the CBEND SEA workshop by agreeing that charcoal harvesters obviously take out big trees because they provide the greatest yield of wood, but that this is not an environmentally damaging practice. If bush thinning is done properly, small trees are able to grow into large trees, and so long as the correct species are cut, not protected trees, then no harm is done. He points to his FSC certification for which Jumbo Charcoal has qualified for many years, as proof that the harvesting process is legitimate and sustainable.

Very few farmers made comments about the policies around bush encroachment. One comment was that the regulations apply to 'forests' but not to invader wood – there should be regulation of bush too.

Many raised concerns that implementation of regulations and law enforcement is very poor. Regulation and control of the wood sector should be carried out by DoF, but most farmers said this does not happen. DoF has too few staff, inadequate vehicles and travel kilometers, and poorly trained staff. Since this is the case, some farmers suggested that the Namibia Woodland Management Council (WMC) should fill this role. The sector needs some monitoring and control, but without inflicting a lot of beaurocracy.

One farmer stated that in the past, DoF inspectors used to give training and advice as they did their rounds. This no longer happens, and frequency of inspections is also less, so that it is true that many inappropriate trees e.g. big mopanes, are being taken out for charcoal purposes. Charcoal permits become renewable every 6 months, but inspecting to see that the operations are being done according to the criteria is inadequate. Also, if a permit to one farmer is denied, the harvesters just move to another farm and continue their bad practices there. There needs to be more law enforcement, and better training of harvesters so that they understand and carry out sustainable practices.

There is a similar concern about regulation in the electricity sector, where many feel that the regulatory oversight and support by the ECB is lacking, especially when dealing with NamPower (e.g. see Section 6.6.4).

6.5.2 Potential permitting problems

There is a concern that a CBEND entrepreneur is vulnerable through the fact that wood harvesting permits are issued for 6 months at a time. What if a CBEND plant is established at great cost, and the operation is then denied permission to harvest bush? Could a CBEND plant get a permit to harvest bush for 10 years? This issue was addressed to DoF officials, who were adamant that the duration of permits cannot be extended beyond 6 months. This is to ensure that bush harvesting is done sustainably and targets the correct species. So long as there is adequate bush from which to harvest, and the harvesting is done appropriately and legally, a CBEND operation would not be denied permission to harvest. It is suggested in the recommendations that the Environmental Contract drawn up for a CBEND operation stipulates the management and monitoring methods that would ensure that a CBEND operation is not jeopardized by the permitting procedures.

Similar concerns arise with respect to the Generation Licence and dealing with the REDs, and they should be resolved during the pilot project to ensure that problems do not arise during future CBEND replication.

6.6 Technical issues and concerns

This component considers the downstream side of the plant, i.e. after the electricity has been generated. Stakeholders involved in the technical side of electricity generation, transmission and tariffs are the ECB, NamPower and the relevant RED. Their roles can be summarised as follows:

6.6.1 Electricity stakeholders

Electricity Control Board (ECB)
The Electricity Control Board (ECB) is a statutory regulatory authority established in terms of the Electricity Act (Act 2 of 2000). It has the core responsibility of regulating electricity generation, transmission, distribution, supply, import and export in Namibia. The ECB's role is further to regulate the trading of electricity and to protect the end-user through managing licensing, tariffs, quality of supply, dispute resolution, industry restructuring, etc.

Any entity interested in the generation, transmission, distribution and trading of electricity needs to apply for a licence from the ECB. Any tariff needs to be agreed and approved by the ECB.

NamPower
NamPower is the national power utility of Namibia and specialises in the generation and transmission of electricity. NamPower can be regarded as a "bulk" dealer of electricity. Since NamPower only operates on transmission level (i.e. 66 kV and above), most distribution infrastructure (i.e. less than 66 kV) and operations are managed by Regional Electricity Distributors (REDs).

Regional Electricity Distributors
The REDs were established to undertake the supply and distribution of electricity to customers in defined regions across Namibia. REDs operate the power systems of 33 kV and below.

6.6.2 Grid Connection

Electricity generated by a Generator needs to be accommodated or absorbed by a distribution network if it is not consumed immediately by a dedicated consumer. In order for a Generator to connect to a network, an electricity meter must measure the amount of electricity transferred and a transformer is needed to step up the voltage from the generation (normally 400 V) to the distribution voltage (either 11, 22 or 33 kV).

If all the electricity produced by the Generator is to be consumed within the local RED reticulation (i.e. by all the RED customers on that particular reticulation), this is referred to as "embedded generation" and no Supply Agreement or PPA with NamPower is required. It will then be a deal between the Generator and the RED, based on the guidelines of the ECB. It must however still be confirmed by the ECB whether a Generator and RED can negotiate all aspects of embedded generation without consulting the Energy Trader of NamPower.

If the electricity produced by the Generator will be more than the RED reticulation can consume, there will be a "surplus" of electricity on that reticulation and the excess electricity will have to be fed into the NamPower Transmission Grid (NPTG) through the RED reticulation and the nearest substation. Metering will be done by NamPower at the perimeter of the substation (at the NamPower-RED interface) and also at the Generator connection point (RED-Generator interface). These meter readings will be used to calculate the amount of electricity fed into the NamPower grid. In addition to the PPA between the Generator and NamPower, there will also be a back-to-back agreement between NamPower and the RED to guide the transfer of electricity between the Generator via the RED to NamPower.

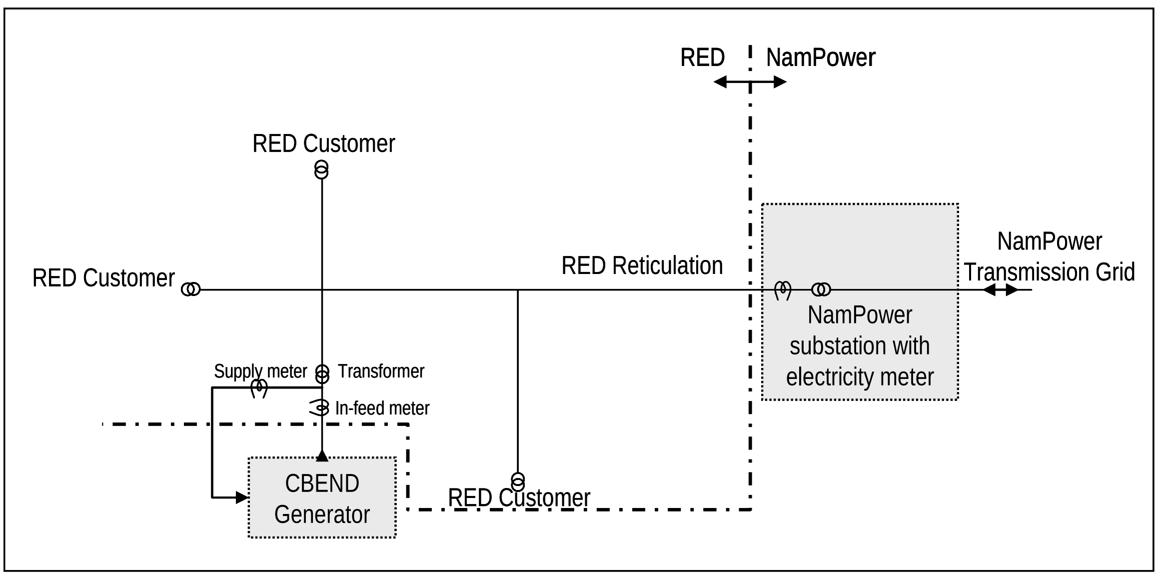


Figure 6.1 Sketch showing a typical substation and reticulation layout.

6.6.3 Electricity Tariffs

All tariffs for electricity need to be approved by the ECB. Since the ECB has a methodology for determining electricity prices, the CBEND component will have to negotiate with the ECB. Should CBEND bargain for some kind of subsidization, this will also have to be negotiated with the ECB.

While CBEND is also considering the possibility of a Generator "selling" electricity to a dedicated consumer at another location on the NPTG, NamPower mentioned that the concept of "wheeling charges"[7] has not been addressed within Namibia. This will have to be addressed in the Transmission Grid Code of the ECB.

The CBEND pilot project has shown that, while the ECB tariff policy is in place, a lot of uncertainty remains about the application of the tariff, especially for small donor-funded plants.

6.6.4 Network stability, synchronisation of infeeding and line protection

Network stability will always remain one of NamPower's main concerns. NamPower and stakeholders are clear that NamPower must conduct the necessary "Load Flow Study" associated with each new Generator connected to the NPTG. The question is who should pay for it – the applicant IPP or NamPower. The ECB has not provided guidance on this point.

NamPower is currently busy with the drafting of policies and standards for synchronizing onto the NPTG. This will be a very important guideline for future Generators.

The requirements for line protection and live/dead operations will have to be adhered to at all times. Since the Generator can potentially energise a power line that is suppose to be de-energised (in case of maintenance by RED staff), these operational interfaces will have to be well organized and coordinated.

The actual composition of the Namibian distribution networks (i.e. long lines with relatively low loads) most often causes Power Factor[8] problems. This, together with the associated stability and grid connection studies etc. that have to be done with every potential generator, has resulted in NamPower's reservations about introducing many "small" Generators into its grid. In NamPower's opinion, they would prefer fewer but larger Generators. Although NamPower would welcome any source of alternative or renewable generation, they noted that the amount of input required and potential instability to accommodate several 250 kW Generators instead of a few 5 MW Generators is much more, hence their preference for fewer large Generators.

Although embedded generation can offer the RED less reliance on NamPower, the Generator will be at risk of "over-generation" should the demand on the particular reticulation drop below the Generator's capacity. This can be managed and mitigated technically, but will have a negative impact on the financials of the Generator.

6.6.5 CBEND Mobility

Although the relocation of a CBEND operation might be required due to unavailability of bush, some technical issues might impact on the viability of relocation. From a technical perspective,

[7] Wheeling charge - a levy that the Generator will have to pay to NamPower for making use of the NamPower Transmission Grid (NPTG) to transfer electricity from the point of generation to a dedicated customer at another location on the grid (i.e. NamPower acts as a "middle man").

[8] The **power factor** of an AC electric power system is defined as the **real power** flowing to the load as a ratio to the **apparent power**, and is a dimensionless number between 0 and 1 (frequently expressed as a percentage, e.g. 0.5 pf = 50% pf). Real power is the capacity of the circuit for performing work in a particular time. Apparent power is the product of the current and voltage of the circuit. Due to energy stored in the load and returned to the source, or due to a non-linear load that distorts the wave shape of the current drawn from the source, the apparent power can be greater than the real power. In an electric power system, a load with low power factor draws more current than a load with a high power factor for the same amount of useful power transferred. The higher currents increase the energy lost in the distribution system, and require larger wires and other equipment. Because of the costs of larger equipment and wasted energy, electrical utilities will usually charge a higher cost to industrial or commercial customers where there is a low power factor. (Source: Wikipedia)

the connection of a Generator to another location on the reticulation will once again require the detailed technical studies to be performed. It might also require the hardware installed by NamPower or the RED to be replaced or relocated at the cost of the Generator. This makes relocation of a CBEND plant more difficult and more expensive, and in the long run probably means that relocation of a CBEND plant is not a viable option.

7 CUMULATIVE IMPACT ASSESSMENT AND MITIGATION MEASURES

7.1 The envisaged CBEND scenario for roll-out

7.1.1 A typical CBEND operation

Below is a description of the features of a typical CBEND operation. The cumulative assessment is based on replication of this scenario, within the limitations set out in Section 7.1.2.

- One or a group of neighbouring farmers, or GRN on a resettlement farm(s), decide to accommodate or invest in a power plant. There could be up to 160 CBEND projects in the target area (see Section 7.1.2).

- The CBEND plant must be less than 500 metres from a suitable powerline (33, 22 or 11 kV) where infeeding from the plant into the grid can take place. Alternatively, the plant could supply a nearby village or client directly. Farms that supply the bush should be within a 10 km radius of the plant.

- The farm(s) are inspected and an outcomes-based Environmental Management Plan (EMP) is drawn up. The EMP forms part of the Environmental Contract between the farm(s) and GRN.

- Farmers undertake/allow responsible bush thinning so that the habitat on the farm(s) eventually resembles bush-savanna, leaving an appropriate number and diversity of trees per hectare (varies from area to area). The trees that are left are both large individual specimens, and clumps, as well as all protected species. This end result is the ideal future habitat as it enables optimum cattle production, ecological functioning and biodiversity maintenance.

- A typical CBEND project will require between 25-30 staff, combining manual and mechanical methods to cut and transport bush, and to operate the plant. The project could compliment other uses of wood (e.g. charcoal, fence poles, firewood) on the same land, as each can use different components of bush.

- Each CBEND project provides an annual, concise environmental report, and it is inspected on an *ad hoc* basis by GRN and/or an appointed external inspector (could be an FSC expert or a member of the proposed Namibian Woodlands Management Council).

- The costs of bush thinning (and thus restoring the land) are offset by electricity sales or the sale of bush to contractor-generators if the plant is not owned by the farmers or landowners.

- Thinning continues for many years on a rotational basis because of invader bush regrowth. The optimum level of bush thinning should aim to leave 1.5 to 2 times the rainfall of tree equivalents i.e. if the average annual rainfall is 400 mm, the land should have a density of 600 – 800 tree equivalents per hectare.

- The farm(s) are restored to productive rangeland. The level of bush encroachment on a CBEND farm varies as bush is thinned then regrows until its next harvest. After the first pass of harvesting and with ongoing aftercare, bush encroachment is maintained at a level where rangeland productivity is maintained (i.e. density of bush is low enough to allow access by livestock and perennial grass growth) but is not allowed to get so dense that productivity is pushed very low again.

- Farmers continue to operate the power plant, rotating clearing from camp to camp, applying aftercare, and farming according to sound rangeland management principles. The situation of combined farming and energy production continues indefinitely, for as long as the power plant lasts.

7.1.2 Environmental limitations to CBEND replication

In order to refine DRFN's original estimate of the number of CBEND plants that could be established, a mapping exercise was undertaken, guided by four major constraints:

- The need to connect to suitable powerlines;
- The sustainable harvesting area, a 10km radius circle around each CBEND plant;
- Exclusion of areas of steep terrain which are considered to be environmentally sensitive and are generally not heavily encroached;
- The availability of water required for the plant operation.

7.1.2.1 Powerline and ecological constraints

Figure 7.1 shows the grid of suitable powerlines (11, 22 or 33 kV) superimposed on the encroacher bush areas. Circles of 10 km radius were drawn in the core bush-encroached area (greens and grey), without overlap, each representing a potential CBEND area of operation. Each circle was centred on a suitable powerline. Altogether 187 such circles can be drawn, representing the maximum number of potential grid infeeding 250 kW CBEND plants in the core bush encroached areas.

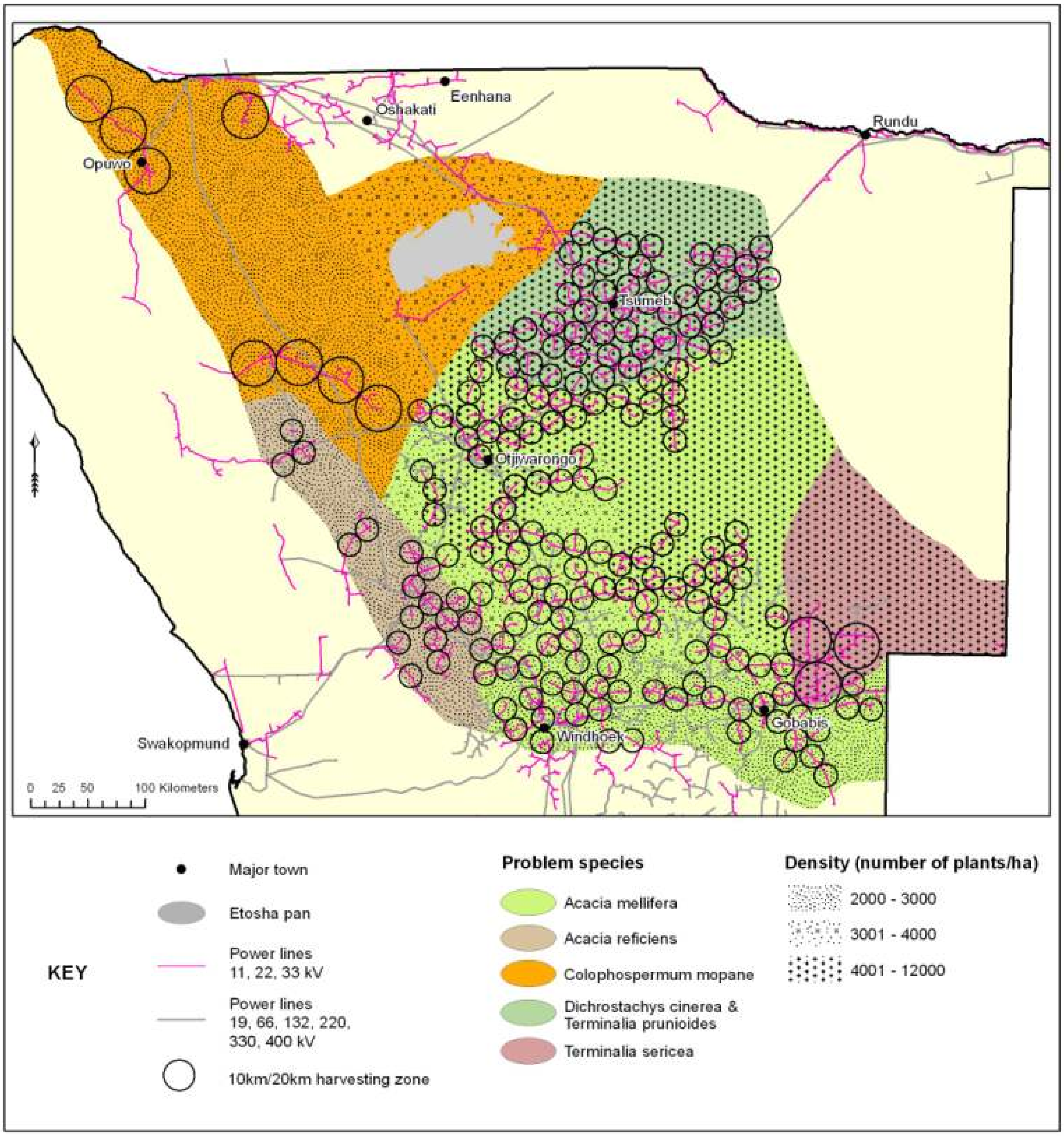


Figure 7.1: Ten kilometre radius circles drawn around potential powerline connections in bush encroached areas

The northwestern and northeastern areas have been treated differently in the above analysis, for ecological reasons. The northwestern orange area is encroached by mopane. These areas are relatively drier, and ecologically different from the central areas. Where mopane is dominant, plant species diversity tends to be low, and where it is cleared, there is a risk that it will not rapidly be replaced by other vegetation. The purple area in the southeast is mainly encroached by *Terminalia sericea* (Silver terminalia), which dominates only on deep sands. Kalahari sands are very infertile and further lose fertility if cleared (Strohbach 2009; de Klerk 2004). In these two areas it is therefore recommended that lower levels of harvesting should be permitted, corresponding to a harvesting area of 20 km radius. This adds only another 11 potential CBEND plants. Two potential locations near Etosha were omitted as they are known to be grassland or not bush encroached as shown in the bush map.

The total number of potential CBEND plants is 187 + 11 = 198.

7.1.2.2 Terrain constraints

There is a concern about the risk of erosion where areas are cleared (CCA 2010; Strohbach 2009). Experience from the bush-related work of the Ohorongo Cement Plant has shown that steep areas are seldom bush encroached, and are usually the most environmentally sensitive areas, containing many protected species of trees. Steep areas are often inaccessible by vehicle as well, making harvesting not only undesirable but impractical. It is therefore recommended that bush harvesting should not be carried out in steep areas.

Digital terrain modelling was used in Figure 7.2 to identify bush encroached areas with three classes of slopes: plains (0-5% slope gradient, coloured green), foothills or rolling terrain (5-10% gradient, coloured orange), and steep slopes (greater than 10%, coloured red). Using the information from Figure 7.1, the potential CBEND plants located on slopes predominantly steeper than 5% (shown as purple circles) were excluded.

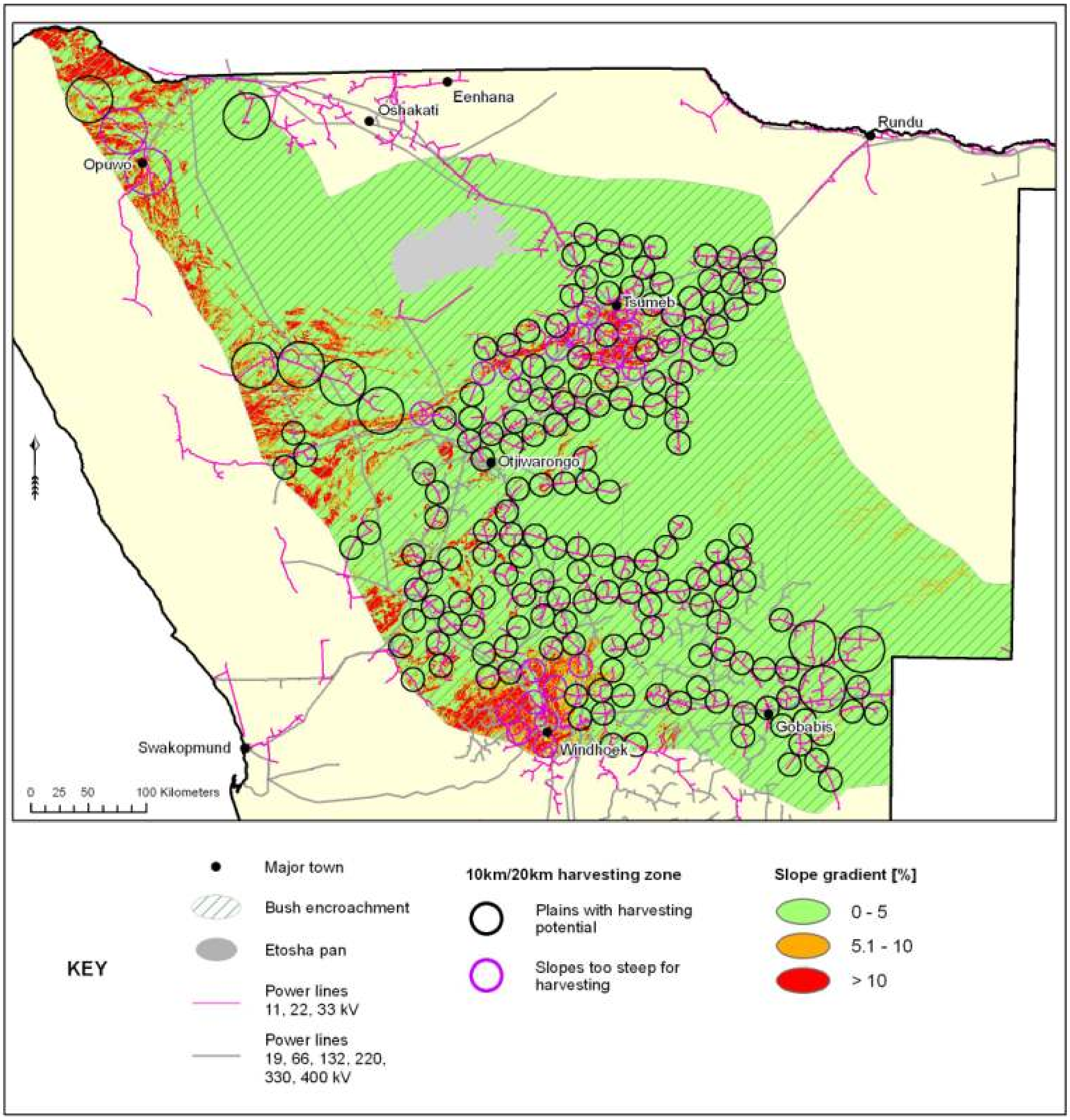


Figure 7.2: Ten kilometre radius circles drawn around potential powerline connections in bush encroached areas, mapped against steepness of the terrain.

The numbers of potential locations that are too steep for harvesting are 18 x 10km radius circles and 2 x 20km radius circles, making a total of 20 locations that are unsuitable and will be excluded from the final count of potential CBEND plants. This reduces the total to 178.

7.1.2.3 Groundwater constraints

Each 250 kW CBEND plant requires 16 m^3 of water per day, which equates to the water consumption of about 300 head of cattle. Therefore, potential CBEND locations will need a substantial surplus of groundwater to be viable.

The 1: 1,000,000 Hydrogeological Map of Namibia (DWA 2001) provides only 'coarse' data but is nevertheless useful to give an impression of how groundwater potential may limit the CBEND options.

Figure 7.3 indicates areas of high, medium and low groundwater potential superimposed on the potential CBEND operations generated in Figure 7.1. Each CBEND circle was assessed and coloured according to its groundwater potential: green (high potential), orange (medium potential) or red (low potential). Since some circles overlapped two or three different zones, the analysis was somewhat subjective. It was therefore carried out in consultation with a groundwater specialist.

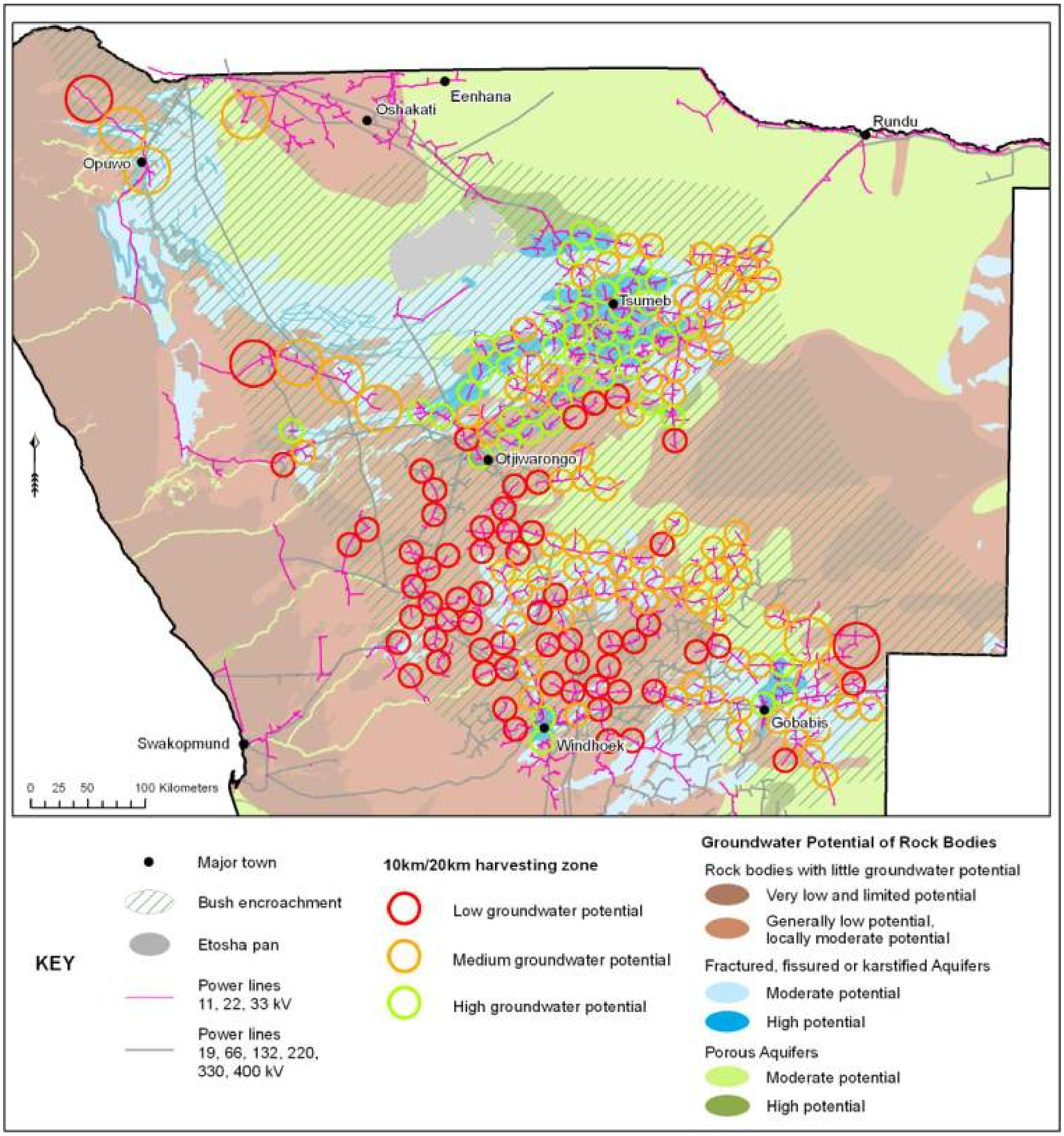


Figure 7.3: Ten kilometre radius circles drawn around potential powerline connections in bush encroached areas, mapped against areas of differing groundwater potential.

Table 7.1 below shows the numbers of circles in each groundwater category.

Table 7.1 : Groundwater potential (for 10km and 20km radius circles)

Type of aquifer / rock body	Colour	Groundwater potential	Number of potential CBEND sites	
			10km	20km
Aquifers: porous, fractured, fissured or karstified.	Darker blue	**High potential. Yields generally above 15m^3/hour (>360 m^3/day).**	45	0
	Darker green			
	Lighter blue	**Moderate potential. Yields generally 3 - 15 m^3/hour (= 72 – 360 m^3/day).**	81	8
	Lighter green			
Rock bodies with little groundwater potential	Lighter brown	**Generally low potential or locally moderate potential. Yields generally 0.5 – 3 m^3/hour (= 12 – 72 m^3/day).**	61	3
	Darker brown	**Very low and limited potential. Yields less than 0.5 m^3/hour (= less than 12 m^3/day).**		
Sub-total			**187**	

On the basis of the DWA map and yields associated with the six colour zones, it is clear that an average borehole in the dark brown zone will not yield enough water required by a 250 kW CBEND plant. Many of the boreholes in the light brown zone will also be inadequate, but some will have sufficient water. However, average boreholes in the blue and green zones should yield more than the required 16 m^3/day for CBEND. Obviously they would need enough for cattle and domestic use as well.

It must be emphasised that the above analysis cannot be used to assess the viability of individual locations. The mapped hydrological data is too coarse for that. Moreover, local variations occur. There could be sites within the high potential areas that do not yield enough, and conversely sites in the low potential areas that do yield enough. This can only be determined case-by-case from long-term pumping tests which would have to prove the groundwater resources needed for the plant and for livestock as part of the feasibility study for a CBEND plant (pers. comm. Christelis 2010). The analysis above is merely a rough indication of the overall numbers of potential locations in each groundwater potential zone.

Bockmühl (2006), working on the Platveld aquifer, found that groundwater recharge improved significantly after bush was thinned. There is reason to believe that this would be true for wider geographical areas as well (pers. comm. Christelis 2010) but this has not been confirmed by research yet. No firm data is available on the additional volume of groundwater that this would make available. Christelis (pers comm) is of the opinion that the improved recharge may compensate for the increased abstraction, but CBEND candidates would not be able to assume this. In any event, the extent of bush clearing per year is small and it would take some years before the extent of clearing is sufficient to benefit groundwater recharge substantially. Therefore, it is recommended that CBEND candidates should do their feasibility studies based on the precautionary assumption that there would be no improvement in groundwater recharge, until proven otherwise.

The analysis above shows that groundwater availability does pose a potentially significant constraint on the number of CBEND plants. Therefore we combined the results of the terrain / slope analysis with those from the geohydrological map.

Figure 7.4 combines the results of Figures 7.2 and 7.3. The purple circles again indicate slopes too steep for harvesting. Since this consideration overrides groundwater potential, the purple circles are excluded from the total numbers of potential CBEND plants. The remaining circles are still classified as high, medium, or low groundwater potential.

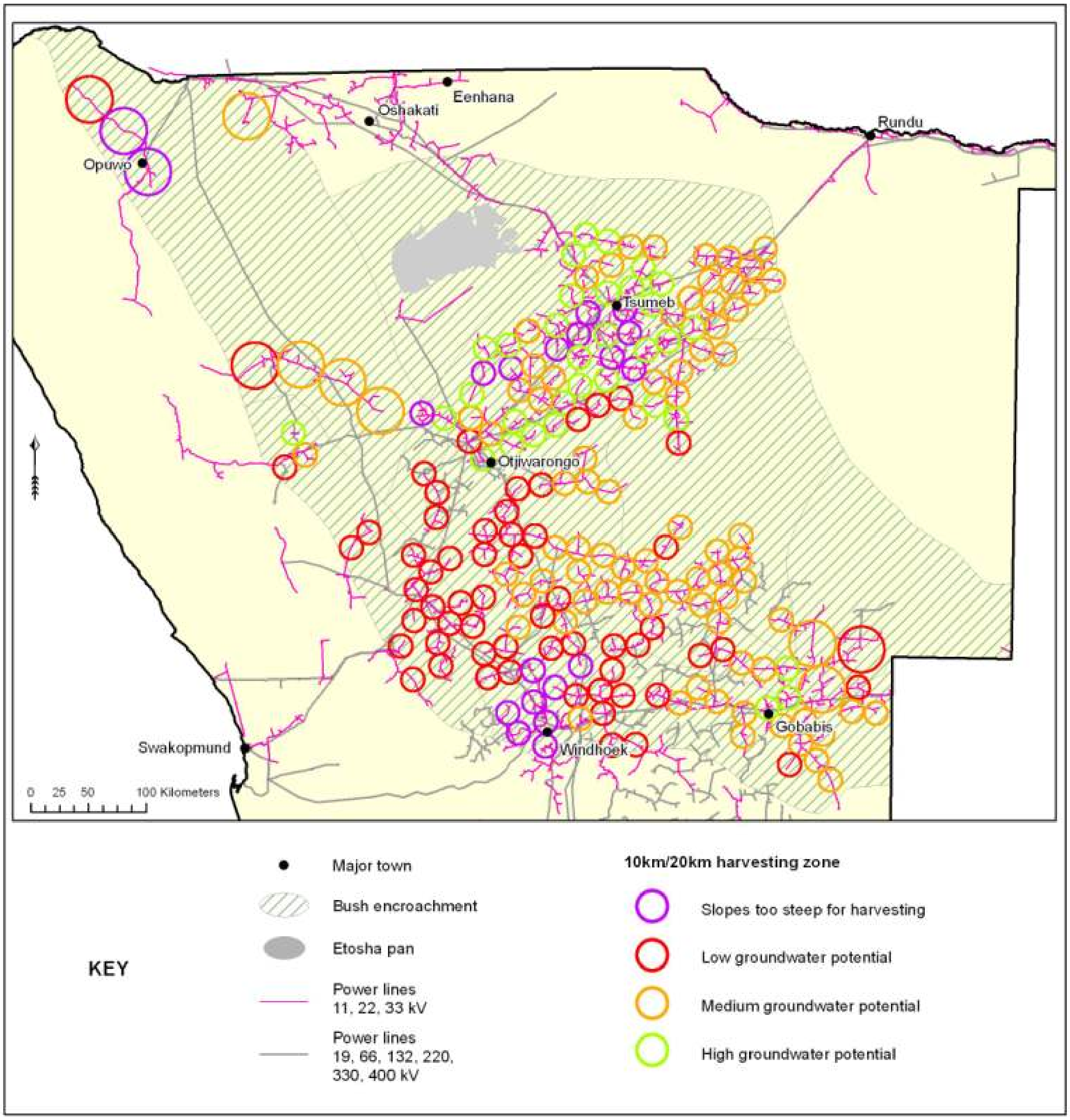


Table 7.2 : Combined: Steep slopes & Groundwater Potential

	10 km radius		20 km radius	
Circles on slopes too steep for harvesting	18		2	
High groundwater potential		33		0
Moderate potential		79		6
Generally Low groundwater potential		57		3
Sub-total		169		9

If we then make a conservative assumption that locations with low groundwater potential will not get enough water, then the numbers of potential CBEND plants are further reduced. The sub-totals become 112 (10km radius) plus 6 (20km radius), making a total of 118 potential CBEND plants. However, at this point the numbers become unreliable, for the groundwater reasons explained earlier.

7.1.2.4 Bush density constraints

So far we have assumed that all the circles showing CBEND potential are in fact adequately bush encroached. In reality, however, not all of the areas are bush encroached. Unfortunately, there is no detailed data available on the percentage of areas that are densely bush encroached (but see Section 9). However, two observations are relevant here: Firstly, low level flights and oblique aerial photos over bush encroached areas show that there are many open areas within them. Secondly, data collected during the Ohorongo Cement Plant EIA showed that roughly 44% of the area within a 50km radius of the farm Sargberg was bush encroached and could be targeted for bush harvesting (CCA 2010). (Note that most of the area for potential CBEND plants has less mountainous terrain than the Ohorongo study). Based on the above experience, the number of potential CBEND plants could be further reduced, perhaps by as much as 50%.

Because there is considerable uncertainty over the availability of both groundwater and bush, an attempt is made in Table 7.3 below, to present scenarios based on clear assumptions.

Table 7.3 : Estimated number of CBEND plants under different scenarios

Scenarios (all exclude locations that are too steep to harvest)	**Potential Number of CBEND plants**
• In a very unlikely scenario, every one of the potential locations identified has enough groundwater, and enough bush to be harvested sustainably. This represents our estimate of the maximum number of potential CBEND plants. (This applies to CBENDs with grid infeeding connections.)	178
• In the event that locations in low potential groundwater areas do not get enough groundwater, but all those with sufficient groundwater in the moderate and high groundwater zones have enough bush to be harvested.	118
• Same groundwater scenario as for (b) but only 50% of locations have enough bush.	59

Obviously, the range of possibilities is considerable. The two factors for which insufficient data is available are actual sustainable yield of groundwater for all the potential locations, and the amount of bush, which has never been mapped in any detail.

We are of the opinion that the maximum number of CBEND plants could be from 60 to 160. Subsequent feedback from the CBEND team has advised that the CBEND model for replication will most likely not stay the same as the pilot project plant. The most likely adaptation and improvement will be reduced water consumption, as the plant is trying to find ways to use the heat rather than cooling it down. Therefore the constraint of water provision might fall away. Other modifications to the template are considered in Section 7.9.

The estimates above are for CBEND plants with connections to the national grid. Other off-grid applications could also be possible, but would probably each need at least one large reliable consumer to anchor the project economically.

7.2 Positive biophysical impacts

7.2.1 Reduced demand on non-renewable energy resources

CBEND will produce electrical energy using local, renewable resources.

The fact that the energy source is local means that energy consumed in transport of raw materials, and losses in the transmission of power, are minimized. Also, the numerous environmental disadvantages that powerlines carry are avoided. The fuel required to transport bush to the gasifier plant and remove any waste products, or to transport bottled gas from the farm site to a possible off-farm generation plant, will slightly offset the benefit described above because transport will use diesel or petrol fuel. Therefore, to enhance the described benefit, total transport should be minimized by siting each gasifier plant in the midst of the bush resource. This will probably be done to optimize the economics of each plant's operations.

More importantly, the CBEND concept relies on the use of a renewable resource, and the targeted encroacher species currently pose a threat in terms of the livelihoods of cattle farmers and integrity of the natural ecosystem. Therefore the CBEND concept presents an opportunity to be part of the solution to those problems, while generating electricity at the same time. This is its greatest positive impact.

7.2.2 Less negative impact in terms of atmospheric emissions

Since any combustion of carbon-based fuel emits carbon dioxide and other greenhouse gases, no form of combustion is totally 'clean energy', but some fuels are 'less bad' than others. When plants grow, they remove atmospheric carbon from the air through the process of photosynthesis. When burned they release that stored carbon to the atmosphere again. However, when the plants regrow they once again remove carbon from the atmosphere. Thus, in the case of biomass, atmospheric carbon is being recycled, and there is no net gain of carbon to the atmosphere. By contrast, when coal and other fossil fuels are burned, there is a net carbon gain to the atmosphere as CO_2 is released from carbon reserves that were previously locked up.

Burning renewable biomass is therefore less negative than burning fossil fuels. Enhancement of this benefit should focus on minimizing total transport in the operations of the CBEND plants, as explained in 7.2.1 above.

The CBEND process is even cleaner than normal combustion of wood, in terms of emissions to the atmosphere, since the wood is first converted to gas in a closed system, and particulate air pollutants are not emitted. There are residues of tar and ash, but these can be disposed of (see section 7.3.2). Another advantage of gas is that it is easier to burn it at a higher temperature than wood. A higher temperature of combustion results in more complete combustion and less pollutants in the air emissions. Thus the emissions to the atmosphere are overall much cleaner than would result from burning the same wood, coal or other solid fuel.

7.2.3 Improvement of groundwater resources after bush thinning

Trees and bush use more soil water than grasses. This is the result of interception of rainfall by the above-ground parts of plants, the extensive root systems of trees and bush utilizing water from surface and deeper layers of the soil, and the high level of transpiration of trees and bush relative to grasses. The net result is that it takes a bigger rainfall event to bring about a given amount of aquifer recharge in a bush encroached area than in an open grassland area.

Clearing bush encroached areas should therefore lead to increased groundwater recharge (de Klerk 2004). Bockmühl (2006) reports that the water table on farms on the Platveld Aquifer north of Otjiwarongo had declined steadily over the past few decades, corresponding with increasing bush encroachment over the same period. Secondly he examined the results of recent bush clearing and found that a significant increase in aquifer recharge occurred locally.

It can therefore be suggested that bush thinning is likely to result in improved groundwater recharge near the area being harvested. The impact of increased groundwater recharge could be beneficial for individual farmers, and the cumulative benefit over a wider area may even be significant in the medium to long term.

It is an open question whether the benefits for groundwater recharge would offset the consumption of groundwater used by the plant. It may be possible to answer this question once the pilot plant is in operation. For this purpose it is recommended that appropriate rainfall and groundwater level records should be kept on the farms affected by the pilot plant and bush clearing (and perhaps neighbouring farms), starting immediately.

7.2.4 Improved rangeland productivity

The CBEND approach, which involves bush thinning to achieve the recommended densities of trees and bush rather than complete clearing, will have a highly positive impact on rangeland productivity. The loss of grazing capacity to Namibia has been estimated at about N$1.2 billion at today's beef prices. Once grassland savannas have been taken over by bush, some form of intervention is needed to restore an area to productive rangeland.

7.2.5 Improved biodiversity status and integrity of the savanna ecosystems

Simmons (2009) reviewed studies that showed that the diversity of bird species is lower in bush encroached areas, and is also lower when all the bush and trees are removed. Thus an open savanna matrix containing scattered large trees, some dead trees and some bush clumps of 1 – 4 ha, represents the optimum conditions to attract a wide diversity of bird species. The diverse plants and vegetation structure provide critical resources for birds, such as refuge, nest sites, and food sources.

Furthermore, those species of birds of greatest conservation concern, viz. raptors, benefit from dense bush being opened up. Those smaller species that actually favour bush are all common and widespread. Therefore it is concluded that the CBEND project would lead to a net benefit for bird diversity. Furthermore, none of the species that are endemic to Namibia would be threatened by the CBEND project.

The CBEND concept, if widely replicated and well managed, will help to restore conditions resembling the original high diversity of habitats. This will lead to increased diversity of animals such as small mammals, reptiles and arthropods.

7.2.6 Improved sense of place and aesthetic value

Bush harvesting is likely to have a positive impact on aesthetic and ‘sense of place’ issues, if large areas of bush encroached land are restored to sparsely treed savanna. Sensitivity to this issue is important not only for the benefit of Namibian residents but also for tourism.

However, the bush thinning must be done properly to have this desired effect. Excessive clearing, or preferential removal of large trees, or subsequent re-infestation with even thicker bush, will not create the optimal rangeland conditions and savanna integrity that are desired.

7.3 Negative biophysical impacts and recommended mitigations

7.3.1 Large water requirements of the plant

The CBEND gasifier plant requires large volumes of water for cleaning the wood gas and cooling the gas generator set by evaporation. A 250 kW plant requires 16 m^3 water per day to make up these evaporative losses. In addition, water with a high lime content needs to be treated and this adds another 300 litres per day of brine residue.

The required water must come from groundwater. This level of water use is roughly equivalent to the daily consumption of water for approximately 300 head of cattle. Anecdotal reports from some farmers indicate that, on some farms, water is already becoming a limiting factor for livestock production. The availability of groundwater could therefore be a fatal flaw in some cases.

The cumulative impact of water abstraction for CBEND plants is not considered to be a significant threat to replication. So long as groundwater testing has shown that the resource for each individual CBEND plant is adequate, then the total groundwater reserves of the area are not expected to be depleted or threatened.

Impact management

The following possible solutions are suggested:

The best solution would be to find a technological solution whereby the heat can be gainfully used in another process, so that the large amount of cooling water is not required. Methods to cool the plant by air rather than with water are available, yet prohibitively expensive. Making use of the heat as a commodity is the most practical mitigation measure concerning groundwater.

Secondly, a CBEND project may locate near to a mine that has to dewater underground chambers, so that water could be drawn from that source. Perhaps a small number of plants could use water from such sources.

Wherever groundwater is needed for cooling, it will be essential to conduct a detailed assessment of the groundwater resources to establish whether the yield will be sufficient on a sustainable basis, to support both livestock and the power plant.

Monitoring of groundwater levels on a regular and long term basis will help to establish whether there is any decline in groundwater level over time.

7.3.2 Potential pollution of soil and water

The CBEND pilot plant has not yet been established and there is currently very little information available on the pollutants. Once the plant is operational it will become possible to undertake chemical analyses of the various waste products that have the potential to get into the environment and cause pollution to soil, surface water or groundwater.

The gasifier plant produces the following substances which have been considered as potential sources of pollution to soil and water.

- contaminated water used to clean the gas,
- ash,
- tar,
- brine (presumably contains whatever was in the groundwater, but more concentrated).

Analysis of the tars produced from the Tsumeb smelter when it operated partly on wood fuel – mostly sicklebush (*Dichrostachys cinerea*), but also including tambotie (*Spirostachys africana*) and sometimes supplemented with coal – was that it produced some residues that were toxic and hazardous (pers. comm. Walmsley 2010). The toxicity could possibly have been caused predominantly by tambotie wood, which is known to be strongly poisonous (Palgrave 1977). The opinion was that the tars should not be fed back into the power plant where these residues would be sent into the air, nor should they be used as a wood preservative as any exposure to the volatiles coming from the tar is noxious, and handling of such treated wood would cause swelling and lesions on the skin. The poison from this wood should not be underestimated.

The cumulative impact of these potential pollutants is possibly a significant threat to CBEND replication. Adequate mitigatory measures need to be put in place, as suggested below.

Impact management

Tambotie trees should never be cut or used as CBEND fuel. This species is a legally protected tree, and is not an encroacher.

The highest priority before replication of CBEND plants must be given to assessing the toxicity of the tar residues. This must ascertain whether the tar residue is still so toxic, given that tambotie wood will not be harvested. If so, then the tar poses a significant pollution risk, and needs to be safely disposed of in hazardous waste disposal sites. The closest properly managed hazardous waste disposal site is in Windhoek. Methods for safe disposal and management of the tar should be in place before further CBEND plants are considered.

It is possible that the Ohorongo Cement plant might be able to burn the tar in their kilns, which operate at much higher temperature than the CBEND plant. This option should be investigated.

In the case that the tar, in the absence of any tambotie, is not highly toxic, then it could probably be used as suggested by DRFN: fed back into the plant, or used on the farm as a wood preservative.

The contaminated water and brine should be led to a small evaporation pond where the water can be driven off. The pond should be situated so that when it is closed up after closure of the CBEND plant, the salts will not be able to be washed out and enter surface or groundwater sources.

A considerable amount of ash will be produced by the CBEND plant. This should be used on the farm as suggested by DRFN, or it can be redistributed over the harvesting areas as a means to improve soil fertility (Section 7.3.4).

In the event that the toxicity of the waste products is proven to be low, there is no cumulative negative impact from the waste products of many CBEND plants.

7.3.3 Increased risk of harvesting the wrong trees

Important species of plants include all protected species and browser species. There is a risk that these desirable species could be removed by indiscriminate harvesting, either by machine or manual methods.

Mechanised cutting carries the risk that all trees will be harvested indiscriminately. It is easier for the operator to do this than to purposely avoid damaging or felling certain trees, and in the case of large scale machinery, visibility is hampered because of dust and the operator might have difficulty identifying trees that should not be felled. The use of manual labour is no guarantee that the encroacher species will be cut and the desirable species will be left. Mannheimer (pers. comm. 2010) and Strohbach (pers. comm. 2009) have expressed concern about indiscriminate chopping that has been observed in some harvesting operations for charcoal production. The risk that the wrong species will be cut is increased if labourers are paid on a weight basis, as they are more inclined to harvest denser trees such as *Acacia erioloba* (camelthorn) and *Combretum imberbe* (leadwood), which are protected.

The cumulative impact of widespread cutting of valuable and protected trees could be significant. These trees are particularly important for ecological integrity of the savanna, as they provide services such as food, shelter, nesting places for birds and animals, and are more resilience in times of drought than smaller species with less established root systems. They are also important for giving open savanna its sense of place.

Impact management

Whether machine or manual labour is used, all bush cutters need to be trained on which trees to target, and this should be complemented with supervision by a person who is committed to harvesting properly.

Assuming there is better control at the shredder, it might be possible to set a limit on stem diameter there. Branches exceeding the size limit would be rejected and the wood gatherers would see that cutting of large trees in unprofitable. Similarly, it would be better to pay harvesters per unit area thinned rather than by weight, but this would be very difficult to implement.

Monitoring of the species which are felled is more difficult. Once a tree is shredded, it is impossible to identify. A ‘before-and-after’ comparison of the tree community might not be possible if one cannot get access into very densely encroached areas. Monitoring should therefore concentrate on assessing the vegetation community of harvested areas against the description of the ‘pristine’ vegetation for that area (provided in Section 5.1.5). This approach recognises that it will be difficult to identify instances where the wrong species are felled, but it will become evident over time if there is a decline in the proportion of certain important species. This emphasizes the need for diligent monitoring and checking for compliance as specified in the EMP.

If the mitigatory measures are properly applied and bush thinning is done appropriately, assisted by thorough supervision, then indiscriminate cutting should be kept to a low level in CBEND harvesting operations. Replication of many CBEND operations will therefore place a heavy responsibility on the authorities (DoF and MET) to ensure that cutting and harvesting procedures are carried out properly.

7.3.4 Potential for soil erosion

The potential for soil erosion arises from the clearing of vegetation cover, exposing the soil to rain and wind. The method of clearing has a large influence on the vulnerability to erosion – certain machines remove all the vegetation, while hand cutting or use of mechanical saws can be selective so that the grass and herb layer is left mainly intact.

The second factor affecting the risk of erosion is slope. Obviously the steeper the gradient the more rapid is rainfall runoff. CCA (2010) recommends that harvesting from steep slopes (steeper than 12%) should be avoided, while footslopes (say 5 – 12%) should only be harvested with special precautions described below. On the plains (less than 5% gradient) the risk of erosion is greatly reduced.

The third factor affecting the risk of erosion is soil type. Grain size and soil composition affect infiltration and therefore runoff. It is easy for rainfall to infiltrate Kalahari sand, so even though cohesion is poor, runoff is relatively low. However, silty soils also have poor cohesion but permit less infiltration and thus generate more runoff. Silty soils are particularly susceptible to erosion, and should therefore be avoided except on the plains. Clayey soils have greater cohesion and are generally less erodible, but Namibian soils are generally very low in clay content except close to major rivers.

In summary:

Lower risk of erosion	**Higher risk of erosion**
Hand labour (which may include mechanical saws) leaving grass and herbs intact.	Harvesting machine, which removes grass and herbs as well as woody plants.
Plains (slopes less than 5%)	Steeper slopes
Clay soils and loams (good mixture of particle size with good organic content)	Sandy soils, silty soils

Impact management

Steep slopes should be excluded from harvesting activities, while medium slopes (5 – 12%) should only be harvested partially, such as by leaving contour strips of vegetation (say 2 m wide) between cleared strips (10 m wide) and ensuring no disturbance to the soil surface.

Only manual harvesting, with hand-held machinery included, should be done. Training should be provided to harvesters so that uprooting of trees or other damage to the grass and herb layer is minimized.

The calculation of the maximum number of CBEND plants (section 7.1.2) is made with no harvesting on medium and steep slopes, but the coarse resolution of the mapping means that, at the local scale, there might be some areas where these slopes occur and where bush encroachment would benefit from the CBEND approach. However, with the above impact management considerations in place, little erosion should occur on any individual CBEND-like operation, and the cumulative impact is also negligible.

7.3.5 Potential loss of soil fertility

De Klerk (2004) has reviewed extensive research which shows that the relationship between trees/bush and grass is extremely important for soil fertility. If an area of bush is completely cleared, soil fertility can be expected to decline over a few years. This occurs for various reasons: firstly, nutrients may be leached out by rainfall, especially in sandy soils. Secondly, soil organisms that fix atmospheric nitrogen are adversely affected by higher soil temperature and lower soil moisture. Thirdly, acacias and other leguminous plants have nitrogen-fixing nodules on their roots which take in atmospheric nitrogen and make it available for their own growth and that of surrounding plants. When these trees/bushes are removed, the replenishment of these nitrates is interrupted. Some of the most nutritious grasses are often found growing in the shade of, or close to trees and bush.

The optimum density of trees and bush is defined by De Klerk (2004, p.18) as “the number of tree equivalents per hectare after thinning should be in the order of 1.5 to 2.0 times the long term average annual rainfall in mm”. Thus an area with average rainfall of 400 mm/a should optimally be thinned to about 600 – 800 tree equivalents per hectare.

If bush harvesting activities for CBEND-like plants are done carelessly, potentially clearing excessive bush and causing loss of soil fertility, the cumulative impact could be significant, resulting in decline of rangeland productivity rather than improvement.

Impact management

To prevent loss of soil fertility, bush thinning should aim for the optimum tree and bush density described above. In the interest of genuinely combating bush, rather than simply targeting those trees that provide the most wood, harvesting should leave all or most of the large trees (over 4 m in height), and target the relatively smaller trees and thorny bush.

Removing woody material from site obviously removes a source of organic matter and nutrients. To offset this, not all wood should be gathered from felled bushes and trees, so that the fine branches (which carry most of the leaves) are left in the veld to create a natural mulch, gradually decompose naturally and return their nutrients to the soil. The fine branches that lie on the surface also create shelter which protects young grasses and herbs, and so helps to promote the growth of those plants that contribute to the plant diversity that good rangeland management aims for.

The ash from the CBEND plant can also be considered for fertilizing areas that have been harvested. This could be collected in drums and transported out to the harvesting areas, and dumped randomly around to be worked into the soil by wind, water and soil organisms.

These simple activities can greatly assist soil quality, which is the key to restoring rangeland productivity.

7.3.6 Risk of increased encroachment after bush thinning

Cutting bush, whether by hand or machine, can lead to increased density of bush because of vigorous regrowth. This is mainly dependent on the encroacher species. In the case of *Acacia mellifera*, seeds do not remain viable in the soil for more than a year, so regrowth is mostly from stumps. However, because seeds of *Dichrostachys cinerea* stay viable for a few years, the regrowth is from both stumps and prolific seeds, and the density of bushes increases.

Impact management

The approach to aftercare needs to be considered for particular species and planned accordingly. For *A.mellifera* it may be sufficient to apply methods such as hand application of herbicides or stem burning. A more aggressive aftercare strategy, and perhaps a wider range of methods, will be needed for *D. cinerea*. The high concentration of young plants may demand that less labour intensive strategies be used, such as intensive grazing by goats, use of fire after a year or two to kill young seedlings, and other methods to follow. A shorter rotation time for bush harvesting may also be necessary.

Another risk is the possibility that one encroacher species could become dominant at the expense of another that is thinned out. We have not found specific examples of this occurring in Namibia, but this has been recorded with alien invasive species in South Africa.

Monitoring of bush density in previously harvested areas should form part of the annual environmental report in the EMP for each CBEND operation. This is outlined in the monitoring handbook.

7.3.7 Increased disturbance to fauna

It is inevitable that some birds nest will be accidentally destroyed during harvesting operations. Also, bird with nests that are close to human activities (including chopping, operation of tractors and shredders, and smoke rising from charcoal kilns) are likely to abandon their nests. The nests of important species such as raptors are usually conspicuous and placed in large trees, hence the need to avoid cutting these trees. Localized areas with relatively dense concentrations of nests – such as along an ephemeral river with larger trees containing nests of vultures – should be excluded from harvesting activities, at least during the breeding season. An attentive farmer should be aware of these things on his or her land and take care to cause as little disturbance as possible.

The presence of people spending their days and camping in the bush is likely to result in greater levels of poaching. Although no species in the bush encroached areas likely to be affected by poaching are of high conservation priority or significantly threatened by this activity, this will lead to loss of wildlife that many farmers are trying to build up for ecotourism purposes. This impact is of medium significance, and very difficult to mitigate. The impact, multiplied many times through CBEND replication, could cause the decline of wildlife populations and loss of revenue from commercial conservancies and game and hunting farms.

Certain species of arthropods are host-specific, with part of their life cycle dependent on particular tree species. Without the host plants, the species of insects and other organisms would be lost from the immediate area harvested. Since some of the host species are also encroacher species, it must be emphasized that some clumps of bush should not be harvested so that no particular species are totally eradicated from an area.

Impact management

The Environmental Management Plan should identify and define sensitive areas on the overall harvesting area for a CBEND-like plant before harvesting begins, and exclude them from the harvesting plan.

Vigilance by the farmer and/or the person in charge of the harvesting teams is necessary to prevent contraventions of the law. Teams that are left on their own for extended periods are likely to get away with poaching and felling of the wrong trees, while those that are visited and checked frequently will be more readily apprehended and the wrong activities penalized and stopped. It all depends on active, involved management.

7.4 Positive social impacts

7.4.1 Employment generation through CBEND replication

A typical CBEND project will require between 25-30 staff. If 160 CBEND-like operations are established, an estimated 4,000-4,800 semi/unskilled labourers could be provided with employment through this initiative. This is a significant positive impact of the project. This source of income helps reduce people's vulnerability to poverty and, by diversifying livelihoods, makes them less susceptible when traditional subsistence farming products and income need supplementation.

The CBEND concept offers a greater proportion of labour that can be resident and accommodated permanently at the plant, compared to the charcoal industry where more labourers work and live in the bush and contracts are more short term.

While the total number of semi/unskilled labourers may suggest that availability of labour is not a problem, it must be stated that some of the work (especially chopping bush) demands heavy manual labour under very hot, demanding conditions. Examples from the charcoal industry in previous east-bloc countries show that as countries progress towards higher levels of development and affluence, fewer people are prepared to engage in demanding physical labour of this nature (pers. comm. Galloway 2010). Thus, although employment creation is a strong potential benefit of the project, this may not be realised through people's reluctance to take on the work that is offered.

It is unlikely that the job of manual wood harvesting for the CBEND initiative will attract many women. The other jobs (Table 3.2) can be conducted by both sexes, although it is more likely that the handling of heavy machinery will be a job that is given to men.

7.4.2 Training and skills improvement

CBEND offers many opportunities for building capacity and skills in its work force. As part of 'on-the-job' training, workers will acquire skills around trees and the principles of rangeland management, technical abilities and other aspects. Positive impacts will extend to the electricity sector, where there will be technology transfer and productivity enhancement.

For instance, since the main aim of a CBEND operation is to ensure land restoration, biodiversity maintenance and improved ecological functioning, then the entire CBEND field team needs to be trained with this objective in mind. Workers will need to be able to recognize different types of trees and know which ones are to be left uncut.

Using the lessons learnt from the charcoal industry, it is suggested that all CBEND workers are educated on their basic constitutional and legal rights, as well as basic life skills in a cash economy (e.g. how to write and read an invoice and how to interpret their payslips).

CBEND plant managers will need training/expertise in:

- Agriculture – either practical experience or a basic formal qualification;
- Book keeping and/or financial management;
- Worker health and safety (a qualification in basic First-Aid is advisable);
- Management of off-site social issues regarding the community where workers and families will be housed;
- Waste management and the safe disposal of the residual waste from the CBEND plant.

Machine/plant operators will need training/expertise in:
- Machine maintenance and operation;
- Waste management and the safe disposal of the residual waste.

7.4.3 Boost to income generation possibilities in off-grid areas

A possible positive impact of the CBEND concept in off-grid areas is the boost that electricity provision can provide for local economic activities. Income-generating activities are more readily achievable with electricity, which CBEND-like operations could potentially provide.

7.5 Negative social impacts

7.5.1 Social ills associated with a migrant labourer situation

Workers living separated from their families, far from their normal social network, often have high vulnerability to substance abuse, HIV/Aids and other STDs. The fact that some of the CBEND labour force will be permanently based on or close to the farm, with family members, reduces the likelihood of this impact. However, there is still a likelihood of about a third of the labour from a typical CBEND operation being migrants, and in the charcoal industry these are mainly drawn from Kavango Region.

Impact mitigation

It is advisable that CBEND employees are encouraged to live with their spouses on farms close to the CBEND plant. In order to prevent too many people from exploiting the CBEND worker's circumstances, land owners will have to specify the number of people allowed per family in their contract.

7.5.2 Increased risk of labour problems on CBEND farms

Similar to the situation in the charcoal sector, there is an increased risk of labour problems for CBEND farmers, which might create a strong disincentive for CBEND replication.

Of course, there is the possibility that labour-intensive harvesting will be avoided by future CBEND farmers in favour of mechanical methods. This reduces the extent of the positive impact that CBEND would have on employment, and opens the possibility of lay-offs.

Impact mitigation

CBEND staff should be employed formally in accordance with the Labour Act of 2007. This means that :-

- CBEND workers will need to form their own class of employees that are registered with and recognised by the MoLSW.
- Certain exemptions (pertaining to overtime/meals etc) from the Labour Act will need to be requested in accordance with Section 139 of the Act. The official form for exemptions is provided in **Appendix G**. Each IPP requires its own exemption certificate – the exemption form for overtime for example, is provided in **Appendix H**.
- Contracts must be drawn up between the land owner and the labourers in accordance to the 2007 Labour Act. A model contract for employees is provided in **Appendix I.**

- Renumeration packages will have to be negotiated with the AEA, NNFU and NAFWU for each of the defined CBEND jobs in accordance with the Labour Act (**Appendix J** and **Appendix K**).
- Land owners will be obliged to provide workers with certain benefits including food rations, grazing rights for livestock, acceptable housing with access to water and sanitation facilities. They will also be obliged to register all workers for Social Security and workmen's compensation (in accordance with the Employee's Compensation Act) and ensure that payments are deducted from their wages.
- Land owners will have to comply with certain procedures for payment in accordance with Section 11(3) Regulation 3 of the 2007 Labour Act (**Appendix L**).
- In the event of a dismissal and/or disciplinary problem, land owners will need to follow certain disciplinary codes and procedures as laid out by the AEA (**Appendix M** and **Appendix N**).

Although the CBEND initiative will not produce products for export, it is advisable that sustainable 'forest friendly' and 'socially friendly' practices as laid down by the FSC are used as guidelines for best practice.

The FSC's Principle 4 seeks to : *maintain and enhance the long-term social and economic well-being of forest workers and local communities, and ; respect worker's rights in compliance with the International Labour Organisation (ILO)*

Principle 4 states that :-

- The communities within, or adjacent to, the forest management area should be given opportunities for employment, training, and other services.
- Forest management should meet or exceed all applicable laws and/or regulations covering health and safety of employees and their families.
- The rights of workers to organize and voluntarily negotiate with their employers shall be guaranteed as outlined in Conventions 87 and 98 of the International Labour Organization (ILO).
- Management planning and operations shall incorporate the results of evaluations of social impact. Consultations shall be maintained with people and groups (both men and women) directly affected by management operations.
- Appropriate mechanisms shall be employed for resolving grievances and for providing fair compensation in the case of loss or damage affecting the legal or customary rights, property, resources, or livelihoods of local peoples. Measures shall be taken to avoid such loss or damage.

CBEND managers should offer a 'hectare-thinned' price to CBEND labourers rather than a 'tonnage of bush cleared' price as they do in the charcoal industry. This will create the incentive for appropriate thinning instead of preferential removal of large trees.

7.6 Positive economic impacts

7.6.1 Improvement of farmland productivity

Cattle production is the main activity in the areas most affected by bush encroachment in Namibia and contributes approximately 80% to the total income of commercial farms in these areas (Buss and Nuppenau 2004).

Studies on the effects of bush encroachment reported an increase in the carrying capacity of farmland through invader bush control - including bush harvesting through thinning (Honsbein and Joubert 2009). They reported a doubling in stocking rates with a 10% clearing per annum in three districts with high levels of bush encroachment (Table 7.4). The data were recorded for an average farm size of 5000 ha with an 80% infestation, and 10% (500 ha) of the total area was cleared.

Table 7.4: Bush encroachment and the increase in carrying capacity after wood harvesting in three bush encroached districts in Namibia (after Honsbein and Joubert 2009).

	Grootfontein	**Okahandja**	**Otjiwarongo**
Bush density per ha	>2000	>2000	<2000
Stocking rate before (kg/ha)	21.4	23.52	11.49
Stocking rate after thinning (kg/ha)	42.8	47.04	22.98
Increase in grass production	10 fold	10 fold	Double
Wood harvest (tonne/ha)	13	13	10

From the above calculations based on the hypothetical farm, a constant increase in gross farm income is recorded with every year's thinning of invader bush. It will take 10 years of thinning operations to cover the whole farm. All else being equal, the farms could record the following additional gross income after 10 years.

Table 7.5: Value of improved profitability from cattle farming in each of the three districts assessed by Honsbein and Joubert (2009).

	Grootfontein	**Okahandja**	**Otjiwarongo**
Additional gross income after 10 years	N$ 429 920	N$ 572 490	N$ 636 600

To keep the calculations simple, this is rounded off to N$500,000 as the average figure for all three districts.

The improvement in beef profits can be complemented by the sale of charcoal or firewood derived from the thinned bush. A hypothetical farm of 5,000 ha could record an additional gross income from firewood sales after 10 years of N$ 1.8 million, or from charcoal of N$2.5 million (Table 7.6, figures derived from Roux 2010, Appendix O). The potential additional income from a CBEND operation cannot be calculated since the infeeding price has not been released.

Table 7.6: Comparisons of the potential profitability derived from improved cattle farming after bush thinning, sales of firewood derived from the bush, or charcoal production derived from the bush.

	Cattle farming	**Firewood**	**Charcoal**	**CBEND**
Additional gross income after 10 years	N$ 500,000	N$ 1,767,000	N$ 2,531,000	?

Overall, these figures show that bush thinning is slightly profitable, and that the margin of profit can be substantially increased if there is further value addition from the harvested wood. The value of CBEND could potentially add to the value addition, as the CBEND process is able to use finer bush which is discarded in the process of harvesting for firewood or charcoal.

7.6.2 Complementarity with other bush products

As discussed in Section 4.1.5, the fuel for a CBEND operation can be gathered from the smaller branches that firewood and charcoal harvesters leave. There is thus no competition for the same resource. The addition of CBEND to a charcoal or firewood producing operation is likely to make the harvesting take out more of the smaller bush, which is the correct size to be targeting for properly combating bush encroachment.

7.6.3 Positive environmental economics rating

Three criteria in the field of Environmental Economics provide a useful summing up, on a qualitative basis, of the economic viability of a project. They are Efficiency, Equity and Intergenerational Equity (Stauth 1983).

Efficiency: A project is considered to be efficient if it delivers a net benefit to society. The contribution of CBEND is twofold.

Firstly it generates electricity, which will make a small contribution to the rapidly increasing demand in Namibia and southern Africa. 160 CBEND plants each producing 0.25 MW amounts to 40 MW, or about 8% of Namibia's 517 MW demand in 2009.

The electricity produced by CBEND may be more expensive than other sources currently, but electricity prices are expected to rise sharply over the next few years, relative to annual inflation, which will make CBEND more competitive. Furthermore, paying a premium for energy that is based on renewable resources is in line with international trends, where governments are providing economic incentives to promote alternatives to fossil fuels.

Secondly, CBEND contributes to solving the problem of encroacher bush in Namibia by achieving some level of cost recovery on bush thinning. Honsbein and Joubert (2009) found that clearing bush was not economical unless some cost recovery could be achieved by using the harvested bush for economic gain. CBEND provides such an opportunity by giving encroacher bush an economic value.

It is quite likely that the economic benefits to society arising from improved rangeland productivity may actually exceed the economic benefits of electricity production.

Equity: The equity criterion relates to the distribution of costs and benefits in the affected society. A project is considered to be equitable if it brings about a situation in which the distribution of social well-being is improved.

The distribution of benefits will include: -

1. Employment creation for harvesting bush and in the plant operation and aftercare programmes,
2. Increased beef production for farmers, to the extent that grazing resources are improved,

3. Stimulation through increased output of downstream industries such as abattoirs, meat wholesalers, secondary (support) industries, exports and foreign exchange,
4. Increased tax revenues for Namibia.

Intergenerational Equity: This criterion extends considerations of equity to future generations. To satisfy this criterion, a project must be able to benefit the present generation without making future generations worse off.

The CBEND concept satisfies this criterion in various ways: -

- Much of Namibia's current electricity production comes from coal fired power stations in South Africa and some in Namibia. To the extent that the production of electricity from renewable resources helps to conserve non-renewable fossil fuels, there is a benefit for future generations,
- The use of renewable biomass is preferable to fossil fuels in terms of the implications for climate change.
- The distribution of benefits mentioned under "Equity" above should continue to future generations at all levels of the benefit chain.

In the event that aftercare is so effective that regrowth is minimal and it reduces the harvestable bush resource, it is assumed that a gasifier plant can be dismantled and moved to a new location where there is still an excess of bush. Thus the CBEND concept is still sustainable, even if the bush resource is locally depleted. However, moving the plant has a negative impact on its profitability and raises a new round of technical conditions that must be met for the new infeeding site. Moving CBEND plants is therefore feasible but practically and financially probably not viable.

No negative economic impacts from CBEND replication have been identified. This SEA noted the conclusion of Honsbein and Joubert (2009) that high value products should be produced from the country's wood resources, to facilitate diversification of Namibia's resource-based economy, and that the CBEND concept shows promise in this regard. A thorough cost-benefit analysis to compare the CBEND concept against harvesting for charcoal or other bush products was not possible since the financial details of the CBEND pilot plant were kept confidential.

7.7 Positive impacts on Namibia's electricity sector

The CBEND concept represents a relatively small contribution to Namibia's current electricity demand of 517 MW, even at the most optimistic scenario of maximum replication generating 40 MW. Nevertheless, the Energy White Paper gives the policy directive to meet peak demand and 75% of total demand from sources within Namibia by 2012. At present, Namibia imports almost half of its electricity requirement from neighbouring countries in the Southern African Power Pool. Thus Namibia must urgently increase internal generation capacity. Furthermore, NamPower established a target of 10% renewables capacity by 2011, focusing on selected technologies (including invader bush), with the first target of 40 MW to be generated from renewables by 2011. In this light, CBEND could make a significant contribution to the country's energy needs and progress towards Vision 2030.

The advantage of renewable energy generation is that small scale operations can be established relatively quickly compared to the long lead times necessary for larger power stations. Given the right market incentives and NamPower support, establishment of many CBEND operations could take just a few years to make the contribution that the Energy White Paper desires.

It must be emphasized that, although the CBEND concept concentrates on grid infeeding, the technology is very suitable for off-grid applications. Wood gasification power plants are available in different sizes ranging from as little as 10 kW to more than 1 MW. Small wood gasifiers, combined with a mini-grid, could thus provide electricity to unelectrified settlements, thus complementing Namibia's rural electrification programme.

7.8 Negative impacts on Namibia's electricity sector

7.8.1 Possible greater instability of the electricity grid

The concerns of NamPower and REDs focus on the greater risk that CBEND operations will bring to the grid. The operation of several CBEND IPPs on a distribution network poses several challenges, due to potential instability caused by several small scale feeders along the network, sensitivity of interconnections, and the possibility of generation not always being embedded.

These increased management and operational requirements will put pressure on NamPower and the REDs in terms of needing more human capacity.

Impact management

Constant monitoring will be required and interactions between the IPP, its RED and NamPower will have to run quickly and smoothly. Not only will it be necessary for IPPs to communicate their respective generation schedules (to make a forecast when and how much power will be generated), but reticulation operations need to be communicated and planned according to the relevant Grid Codes. Unplanned events (e.g. outages) will also require a lot of communication to get all relevant parties correlated and to enable the safe re-energising of the network and start-up of the generator.

A central coordinating agency that liaises with all different CBEND-type IPPs and coordinates the dispatch of electricity should be considered. In this model, NamPower would deal with only with one single entity, rather than many small IPPs.

Due to the dynamics of an electrical grid, each new interconnection will have to be studied to determine the relevant hardware required that will ensure smooth operation and integration at the relevant location. These studies will be once-off during implementation. It is not yet clear who carries the cost (see Section 6.6.4).

7.9 Alternative modes of bush-to-electricity generation as potential mitigatory measures

Some of the negative impacts described above may be reduced by considering modifications to the CBEND concept. Some suggestions follow:

Separation of the two components of a CBEND operation – wood harvesting and gasifying, from electricity generation – would possibly make it more easily manageable for a land owner and/or a potential IPP. The labour intensive part of the operation could possibly be done by one party – the farmer or a wood harvesting SME, while electricity generation could be done separately by a more skilled workforce. In this scenario the party in charge of harvesting would have control over who goes where on the farms, and the IPP would not have to deal with the many issues around farm labour.

Separation of the gasifier and generator plants could make it possible to centralise the generation component in larger (say 5MW) power generation plants, and feed them with gas extracted at small gasifier plants and transported to the generation plant. This was suggested but would involve additional technology and very high costs for gas compression and transportation. While this may reduce some of the technical constraints of small-scale infeeding, it would introduce others and be prohibitively expensive.

Not all bush-to-electricity projects need to involve gasification. Direct combustion is another alternative that is being considered, but it is beyond the scope of this SEA.

8 BEST PRACTICE GUIDANCE AND MONITORING

8.1 Bush thinning guidelines

Bush thinning rather than bush clearing is the key element to harvesting for CBEND. Complete clearing of bush should never be done, as this is bad practice for soil fertility. The rule of thumb is that the number of tree equivalents per hectare should not exceed twice the long term mean annual rainfall, and there should be a range of size classes in the remaining bush. Relatively smaller bushes should be targeted for removal, while large trees (over 4-5 m in height) should not be cut. Thinning should take out less trees in areas where mopane or silver terminalia predominate.

The intention is to restore rangeland to an open savanna matrix containing scattered large trees, some dead trees and some bush clumps of 1 – 4 ha, with a diversity of habitats. Giess' descriptions of vegetation community structure and diversity described in Section 5..1.5 should be used as the goal to which bush thinning is targeted. Browser and protected species should not be cut.

Bush harvesting should not be done at all on slopes steeper than 12%, and slopes from 5-12% should only be partially harvested. This is to prevent soil erosion.

Activities of harvesters should make a point to not disturb nesting raptors or to cut any trees which hold large nests. Poaching of wildlife is prohibited by law and this should be strictly dealt with if noticed. No animals should be unnecessarily disturbed or killed.

CBEND operations can be done alone or in conjunction with other bush-utilising activities such as charcoal production, the manufacture of fence droppers and firewood sales. In this way very little wood will be wasted. As a rough guideline, one third of a 2-3 m high tree can be turned into charcoal; another third can be used for CBEND, and the remaining third of the smallest branches should be left in the veld. There should always be some thins purposefully left behind, as they provide a micro-environment which protects emerging new grasses, and over time they rot and return nutrients to the soil.

For CBEND, it is preferable that bush should not be killed before it is harvested, as this makes it hard and more difficult to cut. This rules out all but manual and mechanical methods as being most appropriate for the CBEND concept. Hand labour is most preferred, so long as the cutters are properly trained to not cut the wrong trees or bushes. Mechanical clearing using bulldozer-like machinery should not be carried out, as it is generally damaging to the soil and wasteful. Smaller-scale machinery such as a cutter-head on an excavator machine can be very selective and efficient. Arboricides (used extensively in the charcoal industry) should never be applied aerially, as this kills all woody plants including protected species and those trees which are beneficial to rangeland health. Application by hand is acceptable as it is more selective.

Aftercare is very important to limit the amount of regrowth after an area has been harvested. Various methods can be applied, including hand application of arboricides, stem burning, and intensive browsing by goats or antelope. Fire can also be considered as a preventative rather than a curative measure to prevent young seedlings getting established.

Plate 8.1 : Due to the importance of trees for soil fertility and more nutritious grasses, the CBEND approach is for bush thinning (left), not bush eradication (right).

8.2 Social and labour guidelines

Bush harvesters should be trained to know which trees to cut and which to leave. There should be supervision in the harvesting areas to keep an eye on this issue.

CBEND staff should, over time, acquire skills around trees and the principles of rangeland management, technical aspects of electricity generation and mechanical maintenance, and work-related tasks. In the electricity sector, NamPower and RED staff should develop work-related skills through on-the-job training.

CBEND staff should be employed formally in accordance with the Labour Act of 2007. Furthermore, ‘forest friendly’ and ‘socially friendly’ practices as laid down by the FSC should be followed.

CBEND managers should offer a ‘hectare-thinned’ price to CBEND labourers rather than a ‘tonnage of bush cleared’ price. This will create the incentive for appropriate thinning instead of for preferential removal of large trees.

8.3 Technical guidelines

CBEND sites need to be located at or near the farms where bush clearing occurs to minimize transport costs.

The groundwater situation must be properly ascertained before deciding on a site for a CBEND plant. It should be adequate to safely supply the required 16 m^3 of water daily for cooling.

The tar residue from a CBEND plant should be tested for toxicity and whether it requires special disposal in a hazardous waste facility. If so, these arrangements must be made rather than just burning the residue in the plant or using the substance on-farm.

8.4 Policy and institutional guidelines

Replication of many CBEND operations will place a heavy responsibility on the authorities (DoF and MET) to ensure that cutting and harvesting procedures are carried out properly, and permitting requirements are followed. The lack of capacity in both organizations at present suggests that establishment of the Namibian Woodlands Management Council should be speeded up so that it can facilitate some of the administrative and regulatory responsibilities. Such a measure is proposed in the interest of preventing over-exploitation of bush resources and ensuring their long-term use.

Similarly, more technical staff will be required in NamPower and the relevant REDs to handle the many potential complications of grid infeeding.

8.5 Monitoring guidelines

There should be a distinction between monitoring for compliance with the regulations, and monitoring to assess the impact of harvesting to gain a better understanding of the CBEND approach. These aspects are more fully described in the separate Monitoring Handbook.

8.5.1 Compliance monitoring

Various government offices should be involved in monitoring the compliance of CBEND-like operations with the legal and policy framework. Evidence of non-compliance should be penalized as a contravention of the Environmental Contract, and punished with restrictions on the activities permitted by a CBEND IPP. This will help to bring about some measure of self regulation.

The CBEND Trust, set up as part of the pilot project, should also be involved in monitoring these aspects at the pilot site and make the information accessible to other parties interested and affected by CBEND replication.

Amount of CBEND replication
The total number of CBEND plants in operation, where the plants are situated, and any relevant details of their operation, will be recorded by DoF and ECB officials through the permitting system. This is the basic information required to give the context for impacts that are detected. The information should be kept on spreadsheets as well as mapped spatially.

Non-cutting of protected species
Inspections of the harvesting area by DoF officials should check that only encroacher species are being cut. This is a difficult aspect to monitor and can only be achieved by a combination of good training and supervision on site, and frequent inspections and interested visits by DoF officials. There should be good incentives for complying with the stipulations of the law and the Environmental Contract, and strict punishments for non-compliance.

Disposal of pollutants
Inspections by DWA and/or MET officials should check that potential pollutants are disposed of properly and do not pose any risk of contamination to groundwater.

Exclusion of sensitive areas and non-disturbance of protected wildlife
Sporadic inspections by DoF and MET officials should ensure that areas excluded from harvesting activities are honoured, and that poaching of wildlife and disturbance to species of high conservation concern does not occur.

Grid stability
NamPower and the REDs will obviously be interested in the stability of their distribution and transmission powerlines, and should keep track of interruptions and disturbances on the lines. Such information, together with the specifications of the connection and the distribution line, can help to avoid the same mistakes or situations in other CBEND replications.

Labour statistics and compliance

The Ministry of Labour should keep track of the number of people employed in CBEND-like operations and how their conditions of employment comply with the Labour Act. This Ministry and the Namibia Woodland Management Council should keep this on a database, to track the employment level from CBEND replication as the context for improved rural livelihoods.

8.5.2 Impact monitoring

Groundwater level and water quality
Ongoing and regular groundwater monitoring is essential if the assumed benefits of groundwater recharge are to be proven and quantified. This must be accompanied by rainfall recording at the farm level, to put the groundwater response in context.

Bush density and recovery rate
As stated in Section 8.1 above, harvested areas should be inspected to measure bush density and diversity of plant species. The benchmark for minimum bush density should be the relevant number of tree equivalents per hectare, calculated as not less than 1.5 times the figure for average annual rainfall. For plant diversity it should be the description of the relevant vegetation type in Giess (see Section 5.1.5). The trend in density for each harvesting area will provide the information to understand the rate of recovery after harvesting.

Data on vegetation community structure and diversity will provide information about the effectiveness of measures taken in specific farm conditions and provide a basis for modifying the methods used – e.g. in aftercare.

Soil fertility and soil erosion status
This should be monitored about once per year or two years by NBRI staff or research staff in government research farms in MAWF. This is not required at all CBEND operations, but can be conducted at a few of them to build up a picture of how harvesting affects soil fertility. Soil fertility should be monitored in several ways:

- Measure certain key nutrients and minerals in soil before harvesting, and then again after harvesting over a period of at least 5 years or more.
- Measure certain key nutrients and minerals in adjacent harvested and unharvested areas.
- Monitor the grass species and density of grass plants over space and time before and after harvesting. Analyse the composition of species and volume of grass production in terms of pioneer / annual species, versus climax / perennial species.

Soil erosion can be monitored with visual inspections at harvesting areas.

Ecosystem monitoring
Since CBEND replication is expected to improve the ecological integrity of rangelands, there should be indicators to monitor this. However, it is difficult to specify indicators that can be directly linked to rangeland improvement through bush thinning in a particular area, Other more general indicators of ecosystem health, such as population status of predators (e.g. birds of prey) are more easily achieved and are also more useful for wildlife and environmental managers who are concerned with the overall health of the ecosystem. Raptor Road Counts have been undertaken in Namibia since the mid 1980s, with some gaps, and provide a robust and quantifiable measure of populations of birds of prey. As the organisms at or near the top of the food chain, raptors give a reasonable indication of the status of animals and plants that support them.

Indicators of socio-economic improvement
Like ecological monitoring, it is difficult to assign indicators which can be directly linked to CBEND replication. Income and expenditure surveys conducted by the NPC should give an overall indication of rural livelihoods in bush encroached areas.

9 RECOMMENDATIONS AND SUGGESTED FURTHER WORK

There are no further steps outlined by the National Planning Commission for CBEND replication: very much depends on the performance of the pilot project and its financial viability. The recommendations below outline possibilities for promoting future replication of the CBEND concept.

9.1 Incentives for CBEND replication

The CBEND concept appears to be just on the margin of viability and does not yet have a strong reason to be picked up as an investment with strong potential for entrepreneurs. It possesses a few constraints, namely the difficulty of recruiting bush harvesters and managing a large labour force, the technical complications of connecting to powerlines and infeeding to the grid, and the obstacles facing new IPPs. It should be noted that the current economic performance of the CBEND pilot plant does not benefit from economies of scale and/or operational efficiencies. Some early lessons also indicate that some of the civil construction requirements were overspecified. The resulting expenses could be avoided on any future plants. Nevertheless, the CBEND concept will require strong incentives to become an attractive proposition for widespread replication. The onus is on the Government to create those incentives, which private sector entrepreneurs will be quick to respond to.

9.1.1 Soft loans

Government should consider that, in the national interest of combating bush encroachment, soft loans from Agribank should be made available for establishment of future CBEND operations.

9.1.2 Grid infeeding subsidy

Participants at the CBEND SEA workshop agreed that a grid infeeding subsidy would be the cleanest and most efficient form of financial assistance to CBEND farmers, as it would reduce cash interactions and facilitate auditing. Subsidising other components of the operation would be vulnerable to corruption and would involve a greater administrative effort. These difficulties would be less likely if subsidization was targeted at the infeeding price that a CBEND IPP receives. This is practiced by other governments internationally (e.g. Germany, UK), which subsidise grid infeeding as an incentive to encourage decentralized renewable energy generation.

9.1.3 Manufacturing status

The CBEND IPP will have to register with the Ministry of Trade and Industry as a business and with the Ministry of Finance as a taxpayer and for VAT. It is recommended that the CBEND IPP simultaneously apply for ‘manufacturing status’ with both Ministries.

A Company or Closed Corporation which has a new business or a substantial extension of a present business that complies with the definition of a manufacturing activity, can apply to the Ministry of Trade and Industry (Division Industrial Development) for provisional registration of manufacturing status. If approved, the business can apply to the Ministry of Finance for final registration as a manufacturer.

‘Manufacturing activity’ is defined slightly differently by the Ministry of Trade & Industry and the Ministry of Finance, but in essence refers to the physical or chemical transformation of materials or components into new products. They are currently working on a new updated industrial classification system - including a new definition for “manufacturing” - according to the International Standard Industrial Classification Version 4.

The CBEND IPP should qualify for ‘manufacturing status’ in that the process involves a transformation into a new product, albeit intangible. If approved by the Ministry of Finance, the following general regulations apply:

- Non-resident shareholders' tax of 10%;
- Dividends accruing to Namibian companies or resident shareholders are tax exempt;
- Plant, machinery and equipment can be fully written off over a period of three years;
- Buildings of non-manufacturing operations van be written off 20% in the first year and the balance at 4% over the ensuing 20 years; and
- Import or purchase of manufacturing machinery and equipment is exempted from VAT.

Additional tax incentives for manufacturers:

Tax abatement
The Government has allowed an 18% special tax deduction on the taxable income derived from manufacturing enterprises for a period of 10 years.

Establishment tax package for new investments
Where companies wish to establish a new manufacturing venture in Namibia, or relocate an existing operation to Namibia, a special tax package may be negotiated through the Ministry of Trade and Industry, which then makes appropriate recommendations to the Ministry of Finance. The Minister of Finance is empowered to grant special conditions to certain manufacturing enterprises on:

- the rate of tax payable, and
- the terms under which this rate shall apply.

To be considered for an establishment tax package, a full feasibility study must be presented showing that:

- existing industries will not be unfairly disadvantaged, and
- the enterprise will contribute positively to Namibia’s long term economic growth.

Special building allowance
Buildings erected for manufacturing purposes (i.e. not office buildings) can be written off at the rate of 20% in the first year and the balance at 8% per year over the ensuing 10 years.

Additional deductions for production line wages and training
An additional deduction of 25 percent will be allowed for registered manufacturing enterprises in respect of wages paid to production line workers and training costs.

Production line wages
As an encouragement to manufacturing enterprises to utilise more labour intensive processes, an additional deduction from income of 25% will be allowed in respect of wages paid to Namibian workers directly involved in the manufacturing process. For example if an enterprise has an approved remuneration package of N$100,000 to such workers, N$125,000 will be allowed as a deduction from taxable income.

Training expenses

An additional deduction of 25% from income will be allowed on approved technical training expenses. The content, duration and costs of training programmes and a list of candidates must be forwarded to and approved by the Ministry of Finance, in consultation with the Ministry of Trade and Industry and the Ministry of Labour.

9.1.4 Secure land tenure in communal areas to support CBEND establishment

Because communal land cannot be exclusively owned or managed, there is little incentive for a communal farmer to spend money on combating bush encroachment. Similarly, there is too much risk involved for an entrepreneur to establish a CBEND plant on communal land, since s/he will have no title to the land itself. The much lower coverage of communal areas with powerlines of the appropriate capacity also considerably reduce the area that is available for grid infeeding from CBEND operations. In the communal scenario, the legal, social and technical conditions therefore almost totally preclude establishment of CBEND operations.

However, there are still opportunities in communal areas where CBEND establishment could be viable. Off-grid min-grid electricity systems could be developed from a CBEND plant, providing that the IPP would be assured of local consumers purchasing its electricity. Such a scenario could be anchored on a project such as a small-scale desalination plant, dairy or a manufacturing enterprise, which would purchase the electricity generated by the CBEND plant. There would need to be secure tenure on the land as a condition for the investment by a prospective entrepreneur.

9.1.5 Other support mechanisms and synergies

The Directorate of Forestry makes budgetary allocation for bush utilization projects, but apparently this has not been used yet. It is intended as a mechanism to create incentives for farmers to combat bush encroachment. This is a further possibility for government to promote CBEND so that it is attractive to farmers and potential investors.

The Directorate of Forestry is responsible for clearing and managing cutlines as fire breaks in communal areas. There is an opportunity here to link this bush clearing with CBEND operations.

9.2 Further studies and information distribution

9.2.1 Assessment of bush densities and monitoring of bush harvesting and recovery

This SEA has bemoaned the little information on bush densities in Namibia, and recognises the difficulty in estimating bush density and bush type from standard aerial photographs. Some further work could quickly change this situation.

In aerial surveys for a different purpose, Mendelsohn (pers. comm. 2010) has compiled a set of high resolution, geo-referenced aerial photos covering a large area around Otjiwarongo, Otavi and Grootfontein. Randomly selected polygons in the overall area have been scored on a scale of 0 to 5 for bush density. This data set needs to be ground-truthed by measuring actual tree densities of those particular areas on the ground. Once this is done, the flying surveys could be extended to cover the greater bush encroached area of Namibia, to arrive at actual densities over the whole area.

This would be a very useful exercise if carried out at regular intervals, say once every 5 years, to monitor the impact of bush harvesting (for charcoal, firewood, CBEND or any other purpose) on the total woody resource. It could help to monitor recovery rates of harvested areas, to get a better understanding of sustainable yields of bush.

This task would be enhanced by updating the bush encroachment map (Figure 5.1) that is recognised to be outdated and in need of revision. The ground-truthing of bush densities could be easily improved by adding encroacher species information, to provide an accurate and useful map to inform the entire bush sector.

There is general concensus that a data gathering and research initiative needs to be set up (probably by the Directorate of Forestry) that looks at improving the current state of information and monitoring the long term impacts of bush clearing and the various aftercare methods applied.

9.2.2 Provide information on bush encroacher and protected species

A few calls were heard during the workshop for a pictorial guide for the use of technical people involved with bush. There should be information on the encroacher species, and on those species which should strictly not be targeted for harvesting. Such a booklet would be useful to farmers, charcoal producers and CBEND operators, staff of the REDs and NamPower who undertake bush clearing along powerlines and tracks, and others. It should be clearly illustrated so that it is easily understood by unskilled labourers. It was agreed at the workshop that this could be produced by the Directorate of Forestry.

9.3 Policy, legislation and institutional recommendations

9.3.1 Finalise the Rangeland Management Strategy and the Policy on Bush Encroachment

Bush encroachment is caused by poor rangeland management, including the tendency of farmers to exceed the carrying capacity and to restrict veld burning. The intention of the Government’s Rangeland Management Strategy is to improve rangeland management practices, which would have the benefit of slowing the tendency for bush to encroach. The ultimate aim of methods to combat bush encroachment should be to restore the ecological integrity of rangelands, which is the best condition for wildlife and cattle productivity.

The Rangeland Management Strategy sets out eight principles of good rangeland management. For instance, an important feature of rangeland management is to retain moisture in the soil. This is done by encouraging perennial grasses, promoting buildup of mulch and more ground cover. These should be the guiding principles that bush thinning for CBEND adheres to.

The draft National Policy on Bush Encroachment in Namibia has been in circulation since 2005 and also needs to be urgently finalized.

It is highly unlikely that either of these policies and strategies will be thoroughly taken up by extension services in the Ministry of Agriculture, Water and Forestry until they are approved and formally accepted. This process should be accelerated so that the benefits of combating bush encroachment that they will help to achieve, can be reached. These benefits extend to the achievement of Vision 2030 and its focus on reducing rural poverty, and will have positive consequences on the broad Namibian economy.

9.3.2 Consider waiving the requirement for EIAs for every future CBEND plant

The Environmental Management Act (EMA) stipulates that any power generating unit greater than 1 MW requires an EIA. CBEND falls below this threshold, and is free of this need with respect to the EMA. However, the ECB demands that every IPP plant requires an EIA, so for this purpose it is necessary.

A request from the client was to assess whether the need for an EIA for every future CBEND could be waived, so that potential investors would not have to deal with this potential 'obstacle' of the project. Is such a blanket waiver advisable?

The EIA of the CBEND pilot project and this SEA have identified the most likely impacts of CBEND plants. Furthermore, the Environmental Contract between the IPP and the government (DoF in MAWF or DEA in MET) should specify the precise mitigations and monitoring activities in the EMP. This should include at least the following:

- A map of the farm where the plant is situated and the areas to be harvested, showing relief, drainage lines, farm boundaries, settlements, infrastructures (powerlines, roads and tracks)
- Any areas where harvesting should not occur (e.g. for ecological, archaeological or social reasons)
- A rough layout of intended harvesting areas over time.
- The written agreement of important stakeholders, with compulsory signatories to the plan being
    - DWA and MoF in MAWF,
    - MET,
    - the farm owner,
    - and the IPP.

This Environmental Contract will form the basis for an annual environmental report to the DoF and MET. Approval of the annual environmental report should constitute approval for ongoing harvesting and transporting permits. Using a 'carrot and stick' approach, there should be penalties for non-compliance with the Environmental Contract, which includes the possibility for suspension of the operation if contraventions are serious or often repeated. This will facilitate self-regulation.

While the EMP must provide essential details, it must be pragmatic and allow for flexibility and adjustments. For instance, a fire or a change of land owner on a harvesting area would demand alterations to the planned harvesting areas. Most importantly, the EMP should be outcome oriented, and not just an administrative requirement. It will require conscientious involvement of the permitting authorities, notably the local DoF and MET officials.

In conclusion, we consider that each prospective CBEND-like operation will not require a separate EIA, but needs a thorough Environmental Contract and EMP which contains the specifications listed above.

9.3.3 Resolve contradictions in forestry legislation and regulations

As mentioned in Section 5.4.1, the inclusion of mopane (*Colophospermum mopane*) as a protected species in the Forest Act conflicts with its widespread utilitsation for charcoal, firewood and potentially CBEND. This conflict should be resolved in the legislation, either by removing it from the protected species list or setting firm criteria for its inclusion in the list and applying appropriate measures to its utilisation. At the moment it is in a 'grey zone' without clear guidelines to its conservation and use.

The issuing of permits granted by the Directorate of Forestry needs to be made more consistent so that rules can be applied firmly and practically, and law enforcement is simplified. For instance, the ambiguity around issuing of transport permits for 2 weeks or 6 months needs clarification.

9.3.4 Establish and constitute the Namibian Woodlands Management Council

A recurring theme amongst farmers involved in the bush sector was that control in the industry by the Directorate of Forestry is ineffective, and that an independent monitoring and regulatory body is necessary. Furthermore, discussions in the workshop revolved around the need for a CBEND implementation unit – a focused organisation that would monitor and manage the overall situation. It would oversee the Environmental Contract of IPPs, facilitate alignment with FSC activities, and be an engine room for permit clearances. Because of the requirements of the Labour Act, it will be necessary for CBEND entrepreneurs, as a class of employers, to seek exemption from certain conditions, in the same way that the charcoal producers have.

These responsibilities and activities could be done by the Namibian Woodland Management Council (NWMC). The organisation could also assist to optimize the business to the benefit of both producers and consumers, and could form an umbrella body over all bush-related industries. It would be able to formalize the charcoal industry, which government desires. It was suggested that the NWMC should be given statutory powers similar to those of the Meat Board and Agronomic Board.

The NWMC has been in proposal stage for a few years, but has not yet been constituted. In the interim, the Namibia Agronomic Board has a management agreement with MAWF to administer the funds for its establishment (pers. comm. Lenhart 2010). Peter Lenhart also suggested that the NWMC could take responsibility for some of the coordination of activities that CBEND replication will involve. We recommend that this organisation be properly established to provide the administrative support that will be required if CBEND replication takes off. To prevent the possible waste of time and money that committees inevitably consume, we suggest that this body merges or is closely aligned with the existing Charcoal Producer's Association in NAU.

10 CONCLUSIONS

The overriding concern from stakeholders was that bush encroachment is a national issue and requires a national response. The CBEND concept could make a significant contribution to solving this problem.

10.1 Most important positive impacts

10.1.1 Large benefit if rangelands are significantly improved

CBEND's primary purpose, to thin bush so that rangeland productivity is improved, is its most important positive impact. There is full agreement by all stakeholders that bush encroachment is a serious problem that causes significant losses to the economy. Some farmers maintain that bush harvesting is its own reward i.e. that the improvement in cattle productivity brings sufficient profit and quickly pays back the money required to clear encroacher bush. Others claim that an outside incentive is necessary to make bush clearing profitable. CBEND offers this incentive, although the profit that can be generated from the operation remains unknown so long as the infeeding price is not known. From an environmental perspective, CBEND is preferable to charcoal production because it uses more of the bush resource and does not produce the emissions that come from bush-burning kilns.

The potential improvement of rangeland is significant for Namibia's resettlement farms, many of which are in bush encroached areas and would benefit greatly from improved rangeland productivity.

10.1.2 Benefit of labour creation

The features of labour generation in a CBEND operation are mostly positive. Up to about a third of the workers are likely to be migrant workers. The remainder, out of a labour force of 25-30 people, will be able to accommodate their families on the farm or close to it, thus reducing the likelihood of social ills normally associated with migrant workers (fighting and alcoholism, STDs, HIV/Aids). There is also the benefit of skills upgrading and capacity building of workers at the CBEND power plant.

Compared to a charcoal producing operation, a CBEND operation carries fewer negative impacts because of the opportunity to employ permanent workers who can be accompanied by their families.

Replicated 160 times, the labour generating advantage of the CBEND concept becomes significant. This is especially true considering the generally poor status and livelihoods of rural workers, particularly on resettlement farms. Essentially, the more CBEND operations, the greater the positive social impact.

This strong positive impact is possibly jeopardized by its potential fatal flaw described below.

10.1.3 Addition to Namibia's generation capacity and renewable energy intentions

Electricity generation by one or even up to about ten CBEND generators will make an insignificant contribution – only up to 2.5 MW – to Namibia's total power needs. Only if replication sees 100 or more CBEND power plants operational – generating 25 MW or more – will the contribution become significant. However, an important advantage of CBEND is that this source of renewable energy does not have the same time constraints as wind and solar power, since electricity can be generated on demand and at the times when it is most needed.

Despite the small contribution, CBEND offers the advantages of local generation using a renewable resource, which agrees with Namibia's intentions as stated in the Energy White Paper. The fact that generation is local means that it has positive value-adding spin-offs in the community in which it is located. Additionally, long distance transmission, with the numerous environmental disadvantages that powerlines carry, is avoided.

There is also a potential benefit to electrification of offgrid areas, so long as the demand is guaranteed and purchase of electricity by the consumers can be secured in the long term. Thus, while the main area of CBEND replication is considered to be in freehold farming areas where appropriate infeeding powerlines exist, this alternative offers the possibility of growing the CBEND concept on communal land where grid electrification is most lacking.

10.2 Potential fatal flaws to CBEND replication

10.2.1 Unwillingness of labour to do bush harvesting work, or of farmers to host a labour-intensive enterprise

The good intention of creating labour intensive enterprises might be fatally flawed by the reluctance of workers to do the difficult and demanding work that bush harvesting involves. Additionally, many farmers cite labour management difficulties as the main reason for not harvesting bush for charcoal, so the labour-intensive approach of CBEND might deter farmers who would otherwise be willing to invest in it.

This potential flaw might be less severe, since only a relatively small proportion of the CBEND labour force (8 harvesters) is involved in chopping bush. If CBEND operations work in synergy with harvesting for charcoal (see below), then the bush cutting component of the work can be integrated with the charcoal side of the operation. The CBEND option will probably be more attractive to farmers who already undertake bush harvesting for some commercial purpose, with well established labour management procedures, than to farmers who do not carry out such activities.

It must be stated that CBEND replication is not forced to follow the labour-intensive route. Mechanized harvesting is the easiest way to avoid many of the labour issues described in this report.

10.2.2 Technical difficulties in ensuring the grid remains stable with multiple small-scale infeeding

NamPower and REDs have expressed concern that they will not be able to cope with many small-scale bush-to-electricity generators. This is due to the technical issues around each transmission line's power factor, ensuring that generation is embedded, and ensuring the stability of transmission. While some of these technical difficulties might be solvable, the situation at present appears that NamPower and the REDs are not able to accommodate a replication scenario that involves many CBEND generators. Possibly a coordinating agency should be put in place, that would reduce their administrative burden in dealing with many small IPPs individually. More significantly, the willingness of NamPower and the political will of the ECB to attract small generators into the power sector, both seen to be low, could effectively kill the CBEND initiative.

10.2.3 High capital cost of the equipment

The very high capital cost of the power plant is a major obstacle to replication. Added to this is the cost of the technical assessments and ensuring stability of infeeding, which may have to be carried by the IPP. This underlines the need for subsidization from government of the infeeding price, so that the cost can be recovered in a reasonable time.

While the capital price is high, it depends on the capacity of the equipment. A 10 kW generating unit would cost approximately N$200,000 when imported at Walvis Bay (the infrastructure costs then increase the total cost). There is therefore the potential for farmers to establish smaller CBEND units.

10.3 Most important negative impacts

10.3.1 Large water requirement

A key constraint for the CBEND initiative is its high water demand. An estimated 16,000 litres per day are required for the evaporative cooling of a typical CBEND plant. This is a large quantity of water that must be available for the operation to proceed. Once operational, the impact on groundwater at this high rate of consumption might jeopardise a farmer's other stock production activities.

This impact can probably be mitigated by finding ways to use the heat for other purposes, which removes the water constraint and increases the value-addition of a CBEND plant.

10.3.2 Risk of bush harvesting removing protected and desirable species

Greed / poor management / indiscriminate bush clearing may result in excessive bush removal and/or removal of valuable non-target species, including protected trees. Additionally, damaging harvesting methods can degrade the environment and threaten biodiversity. In particular, bulldozing and aerial spraying of arboricides are not advised as they conflict with the main aim of restoring rangelands through bush thinning. There will be a strong need for training and close supervision with respect to identifying which trees are targeted and which must not be cut.

10.3.3 Waste products from the operation, including toxic by-products

The very toxic tar residue coming from the wood and charcoal that was used to fuel the Tsumeb smelter emphasizes the potential for similar wastes from CBEND plants. Although preliminary information associated with the pilot CBEND project did not foresee that the tar residue would be hazardous, this still needs to be verified when the plant is operational. If the toxicity is verified, waste management procedures will need to be strictly followed during CBEND replication. It is possible that the toxicity of the tar is associated with tambotie wood only, in which case the negative impact is expected to be much less, since tambotie is not an encroacher species and should not be cut at all.

10.3.4 Increased stress on institutions, particularly DoF and NamPower.

Replication of many CBEND plants will require increased technical and administrative staff in government and its agencies, particularly Directorate of Forestry and NamPower. The present capacity of these organisations raises concerns about future replication. Establishment of the Namibian Woodlands Management Council will help to bridge part of this gap.

10.4 Likely synergies

10.4.1 Complementarity with charcoal or other bush-based industries

The CBEND concept complements other uses of encroacher bush such as charcoal, fire wood or droppers, since it can use finer wood pieces that these activities discard. This synergy should be promoted in the replication of CBEND, since charcoal and fuel wood enterprises are easier to start up than CBEND, and they involve a labour component that, if in place, makes the CBEND operations much simpler to start. Additionally, a farmer that is already involved in charcoal production will have a certain amount of experience and infrastructure on which the CBEND operation can build.

10.4.2 Links between mandatory bush clearing and CBEND

Linking CBEND-like projects with bush clearing done for veld fire management by the Directorate of Forestry or powerline clearing by NamPower and REDs, or components of the bush utilization budget in the Directorate, will help to give greater impetus for CBEND replication.

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APPENDICES A – O ARE SEPARATE FILES