Update of an existing Macroeconomic Impact Assessment for a Biomass Power Station in the Oshikoto region

Final Report

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List of Acronyms

AfDB	African Development Bank
BOP	Balance of Payments
EPC	Engineering, Procurement, and Construction
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit (Bush Control and Biomass Utilisation Project)
IRR	Internal Rate of Return
KfW	Kreditanstalt für Wiederaufbau ("Reconstruction Credit Institute")
$kgCO_2e$	Kilograms of carbon dioxide equivalents
LSU	Large Stock Unit
MIRR	Modified Internal Rate of Return
N-BIG	Namibia Biomass Industry Group
NIRP	National Integrated Resource Plan
NLFS	National Labour Force Survey
NNF	Namibia Nature Foundation
PAYE	Pay-as-you-earn tax (withholding tax on income payments to employees)
SAM	Social Accounting Matrix
SAPP	Southern Africa Power Pool
TCO_2e	Tons of carbon dioxide equivalents

Executive Summary

The purpose of this study was to update a previous similar study, quantifying the micro and macroeconomic impact of a biomass power station and the related encroacher bush harvesting activities near Tsumeb in Namibia.

The assessment is focused on a base scenario, selected in consultation with NamPower, with the other scenarios included as annexures. The variables for this assessment included a multitude of power stations, biomass input prices, exchange rates, and power station capacity factors.

The various options assessed included the following:

1. A single 40MWe grate-fired biomass power station.
2. A phased 2 x 20MWe phased biomass power station, with the second 20MWe coming online five years after the first
3. A 16MWe pilot biomass power station
4. A 16MWe pilot biomass power station, to be followed by a separate 20MWe biomass power station on the same site reaching commercial operations five years after the pilot project.

The assumed sustainable harvesting yield of 12.65t biomass per hectare, on a dry matter basis, is retained (Cirrus, 2018). However, to simplify the modelling, harvesting shall only be modelled done using the fully mechanised method (excavators, bulldozers, etc.).

Assumptions and parameters are based on the previous assessment, unless other new inputs had been provided by NamPower (such as fuel requirements, EPC costs, etc.).

The price of the feedstock received by the biomass suppliers will be analysed at four distinct price points, namely: NAD450, NAD600, NAD750 and NAD900 per tonne, delivered at the power station gate (after correction for moisture content).

Three capacity factors are to be modelled, namely at 50%, 70%, and 85% for the base 40MWe power station.

The fuel requirements will vary according to the different power station sizes and capacity factor scenarios. The harvested areas shall adhere to the environmental clearance harvesting guideline's recommendations (i.e. the area will not be cleared but bush thinned).

Additionally, the overnight capital investment cost per kW installed capacity was modelled at a base case of USD3500, with alternatives of USD3000 and USD4000.

The base scenario:

- 1 x 40MWe grate-fired biomass power station
- Fully mechanized harvesting
- A price point of NAD750/t biomass, corrected for moisture content and delivered to the power station
- Capacity factor of 70%
- Exchange rate of USD1:ZAR14.50

The appendices are summaries of the various modelled scenarios. This starts with the base 40MWe power station modelled at the different capacity factors, followed by the base 40MWe power station modelled at different CAPEX (per kW installed) costs. This is followed by a 'best' (highest capacity factor, lowest capex costs and biomass fuel prices) and 'worst' (lowest capacity factor, highest capex costs and biomass fuel prices) scenario summary. Lastly, the different power stations are modelled (points 2, 3, and 4 above) at a fixed 85% capacity factor and at the various biomass fuel input prices.

Microeconomic Findings

The microeconomic section of the report focuses on the benefits to gross value addition (GDP) in the country, looking particularly at the impact on agricultural output, value addition from biomass harvesting, benefits accruing to the environment and ecosystem services and employment. The power station will directly employ a peak of 287 people during the construction phase, and maintain 62 positions during its 25-year operational phase. The mechanised harvesters will employ 115 people. The overwhelming majority of jobs created by the project will be indirect and induced. Many indirect jobs will be created on the biomass supply chain (i.e. harvesting and processing operations), while induced employment will be the result of the increased local consumption of goods and services as a result of the employment created by the power station and biomass supply chain.

In the agriculture sector, the assumption is that bush thinned land will be used for cattle farming. The model runs under the assumption that the carrying capacity of encroached land is 17 hectares per head of cattle (large stock unit), and that carrying capacity will increase to 10 hectares per head of cattle, four years after bush thinning. Livestock farmers will begin marketing cattle in year four, using the prior three years to re-stock. Over the project lifetime, an additional 1,309 cattle will be added, based on the improved carrying capacities Cattle are valued based on the 2019 average beef producer price and a conversion factor of 250kg per head of cattle.

The environmental and ecosystem services benefits were assessed, with the quantified benefits focusing on improved groundwater recharge and impact on greenhouse gas emissions. An average rate of groundwater recharge at 1% of rainfall is used as the baseline for bush encroached land, while a conservative estimate of improvement to 2% recharge on bush-controlled land was applied. Some studies suggest much higher recharge rates, however this analysis retains the conservative assumptions found in the two NNF studies (2016 and 2017) and thus note a possible bias to underestimate the level of the groundwater resource improvement. The extractable groundwater level increase needs to be offset by the increased water usage attributable to larger cattle herds, as well as water usage by the power station. Once all offsets are accounted for, the extractable groundwater resource is expected to increase by 22.7 million m3 over the 25-year project lifespan.

Burning the biomass to fire the power station is a source of greenhouse gas emissions. However, it is assumed that these emissions will be recaptured by plant growth and is termed biogenic carbon – and therefore has a net zero emissions assumption. However, the supply chain and livestock farming will contribute to emissions. The use of fully-mechanised harvesting and the transport of the biomass to the power station contribute to emissions. The methane emissions by the additional cattle are converted to a CO_2 equivalent. GHG emissions will total a gross 1,193,697,327 kgCO_2 over the 25 years, or 0.19 kgCO_2/kWh. However, the study also considers the grid displaced GHG emissions, given the Namibia and Southern African Power Pool (SAPP) grid emissions factors.

The single largest benefit from a microeconomic perspective is the production of electricity domestically, as opposed to importing such. As the production of electricity is a productive activity, that produces output greater than its input, pays wages and salaries and employs local capital, it has a positive economic impact.

To produce an aggregate value for the microeconomic benefits, a price/tonne of biomass of NAD750 was used. The net present value (NPV) of the microeconomic benefits totals NAD4.965 billion (discounted at 5.5% p.a.), or NAD0.81/kWh.

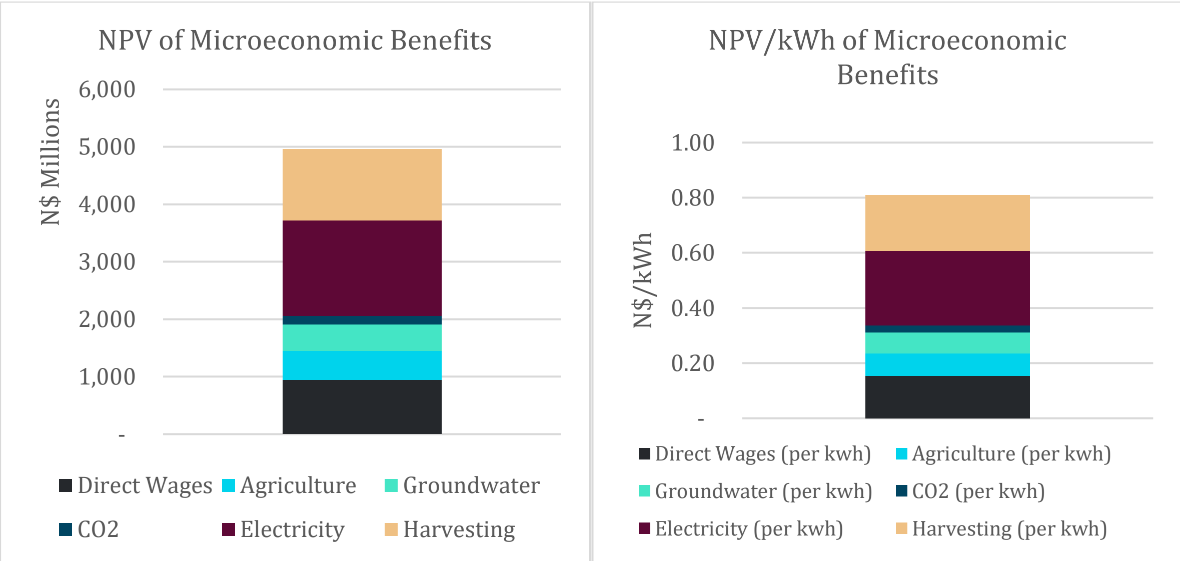

Figure 1: NPV of Microeconomic Benefits

Macroeconomic Findings

The construction of the power station will see the greatest short-term addition to GDP, while the operational phase will provide a lower, but longer-lived contribution. The total construction cost (with contingency) is estimated at NAD2,283 million, on an assumed exchange rate of NAD16.57 to the Euro. Approximately 45% of this will be spent on direct imports (such as the boiler and steam turbine), and will therefore register as a negative contribution to GDP. Only gross value addition (i.e. output less intermediate consumption) on the remaining construction activity positively contributes to GDP. The construction industry has a 2.36x multiplier, implying that for every NAD1 spent on construction, NAD2.36 of output is produced in the economy as a whole.

During the operational phase, the assumption is that power generated is offset against imported power from the Southern African Power Pool (SAPP). In net-present-value terms, the reduced electricity imports (import substitution effect) over the station's 25-year lifespan equate to a benefit of NAD1.17/kWh, as the imported value of electricity over the 25-year period is approximately NAD7.2 billion. The price that NamPower pays for biomass plays a large role in the GDP contribution of the power station. While a higher feedstock price is beneficial to the harvesters, a lower feedstock price is beneficial to the power station.

The indirect contribution to the economy will primarily come from the biomass supply chain and increased agricultural output. The contribution by the biomass sector is, once again, heavily dependent on the sales price of biomass and the harvesting method utilised. At a price point of NAD750/t, the contribution to GDP per kWh increases over the 25-year project lifetime, however this is largely as a result of increased livestock output which is independent of the feedstock price points. The livestock industry has an extensive upstream value chain, requiring inputs and therefore benefiting nearly every other sector/industry in the domestic economy. Similarly, there is also a well-developed downstream value chain for livestock. The implication is that for every NAD1 of output generated by this industry, NAD3.63 of output is generated in the economy as a whole, across various different up-and-downstream activities.

The contribution to personal and company income tax is, once again, heavily dependent on the price point of biomass. With regard to social security, the contributions are minimal, as these contributions have statutory limits.

The impact on the balance of payments sees an initial large outflow in order to import the equipment, however this would be offset by financing obtained from foreign sources, where an initial inflow of funds would be seen, followed by a slow outflow of funds as the funding loan is repaid over the operational phase of the project. The import-substitution effect of electricity is the largest contributor to the positive balance of payments effect, resulting in NAD245 million less leaving Namibia per annum. Increased cattle and beef exports will also contribute in some part to greater exports. The equipment for harvesting, as well as increased fuel imports for harvesting, will offset some of the positive balance of payments effects.

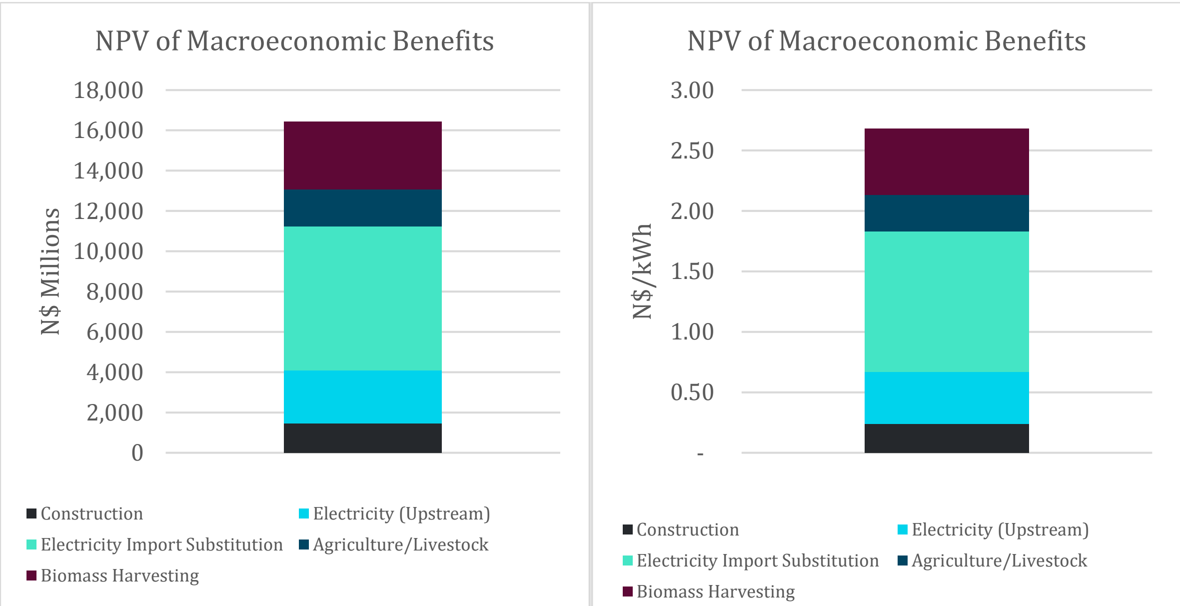

Figure 2: NPV of Macroeconomic Benefits

The net present value of macroeconomic benefits (discounted at 5.5% p.a.) totals NAD16.1 billion, or NAD2.67/kWh.

The larger scale of this 40MWe power plant vis-à-vis the 2018 study on a 20MWe power station result in a significantly larger macroeconomic benefit. However, there have been some adjustments to the assumptions and other inputs. As a reminder, the 2018 study estimated the NPV of macroeconomic benefits (in 2018 prices) at N$4.97 billion, or N$1.33/kWh, for the first scenario (more manual harvesting), and at N$4.76 billion, or N$1.28/kWh, for the second scenario (mostly fully-mechanized harvesting).

Various alternative scenarios were also modelled and included as appendices. For the sake of brevity, the scenarios within the appendices are illustrated through charts and tables highlighting the core results and outputs given the changes to the underlying assumptions and inputs.

Introduction

Background and Context

Namibia faces the challenge that its open savannah, characterized by a mixture of trees, bushes and extensive grass plains, are increasingly changing into a dense bushy landscape by the intrusion and/or intensification of aggressive and undesirable wooden plant growth. This phenomenon is commonly referred to as bush encroachment and affects more than 26 million ha of land in Namibia. Figure 3 illustrates the quantity of biomass that can sustainably be harvested from encroacher bush.

The imbalance in the proportion of grassland to bush leads to a deteriorating biodiversity, a low carrying capacity of the farmland, a reduction in the moisture content of the soil as a result of the increased water uptake by the increasing number of wooden bushes and a resulting decrease in the recharge of Namibia's aquifers.

Due to bush encroachment the grazing capacity of large areas of the Namibian savannah has declined, often to such an extent that many previously economic livestock properties are now no longer economically viable. As such, bush encroachment is considered an important obstacle to the development of the country's meat industry.

The abundance of undesirable encroacher bush and the need for local electricity generation creates a beneficial relationship and an opportunity to utilize this encroacher bush for electricity generation.

Electricity generation utilizing encroacher bush also falls in line with national and local development priorities, serving to provide employment opportunities, skills development, local economic growth and importantly, an improvement in the agricultural carrying capacity of the farmland where encroacher bush is harvested. The socio-economic benefits of increased carrying capacity of farmland are likely to lead to both an improvement in local economic strength, as well as an increased resilience of communities to cope with the effects of climate change and associated environmental stresses.

Electricity generation from encroacher bush also has the added advantage that it is not considered an intermittent energy source. The ability to dispatch the energy generated from the biomass power station on demand allows it to be operated on a base load regime.

In June 2013, NamPower finalised a pre-feasibility study for a biomass power station. The pre-feasibility study assessed the technical, environmental, socio-economic and financial aspects of this project. The use of commercially proven combustion technologies for the conversion of biomass to heat energy for generating electricity was recommended.

In 2018, a micro- and macro-economic impact assessment of a proposed 20MW encroacher bush biomass power station was completed. More recently, in December 2019 a greenhouse gas assessment of biomass utilization in Namibia included a proposed 20MW encroacher bush biomass power station and in October 2020 an environmental impact assessment for a proposed 40MW encroacher bush biomass power station was published.

It is against this background, that there is a need to update the existing macro-economic study completed for a 20 MWe biomass power station to reflect the current market conditions and present the benefits should the project be implemented to an increased capacity of 40MW or even in phases.

Methodology

Prepare a micro and macroeconomic study on a biomass power station and the relating encroacher bush harvesting activities near Tsumeb in Namibia. The project is expected to have a 25-year lifespan.

The assessment will follow one core scenario as its base scenario, selected in consultation with NamPower, and include the other scenarios (power stations, biomass price points) as annexures. The assessment will include an investigation into the competition for the biomass resource, as well as the anticipated impact of the Modified Single-Buyer Model.

Core Assumptions, Scenarios and Parameters:

The various options which will be assessed included the following:

1. A single 40MWe grate-fired biomass power station.
2. A phased 2 x 20MWe phased biomass power station, with the second 20MWe coming online 5 years after the first
3. A 16MWe pilot biomass power station
4. A 16MWe pilot biomass power station, to be followed by a spate 20MWe biomass power station on the same site reaching commercial operations 5 years after the pilot project.

Harvesting shall be done using the fully mechanised method (excavators, bulldozers, etc.).

Assumptions and parameters are based on the previous assessment, unless other inputs have been provided (such as by NamPower, e.g. fuel requirements, EPC costs, etc). A full list of assumptions is annexed hereto.

Scenarios and Parameters:

The price of the feedstock received by the biomass suppliers will be analysed at four distinct price points, namely: NAD450, NAD600, NAD750 and NAD900 per tonne, delivered to the power station (after correction for moisture content).

Three capacity factors are to be modelled, namely at 50%, 70%, and 85%.

The fuel requirements will vary according to the different power station scenarios.

The harvested areas shall adhere to the environmental clearance certificate harvesting guidelines and recommendations (i.e. the area will not be cleared but bush thinned).

Additionally, three exchange rates are modelled. These rates are given as the EUR-ZAR exchange rate, where EUR1.00 is equivalent to ZAR16.57 as the base case. The alternatives were EUR1.00 equals ZAR13.71, and lastly EUR1.00 equals ZAR20.57.

Suggested Core Scenario:

- 1 x $40MW_e$ grate-fired power station
- Fully mechanized harvesting

- Price point = NAD750/t biomass, corrected for moisture content and delivered to the power station
- Capacity factor of 70%
- Exchange rate of EUR1:ZAR16.57
- Price per kW of installed capacity = USD3500

Microeconomic Impact of the Project

Supply and Demand

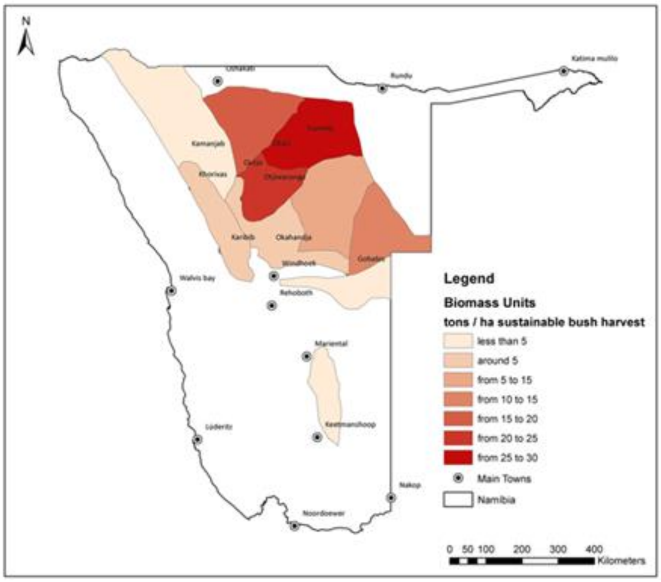

Figure 3: Biomass Harvesting Density

An estimated 45 million hectares of land in Namibia are affected by bush encroachment (UNIQUE, 2019). According to Petrick and Katali (2017), theoretically, there is sufficient encroacher bush biomass to supply 10 power stations of 20MW each for more than 180 years, which does not consider any potential regrowth. It is thus apparent that this resource is abundant, and that production is largely constrained by uses driving demand for the resource.

The chosen site, near Tsumeb, is located in the most encroached area in Namibia, as seen in Figure 3. This area is classified as Karstveld and contains moderate densities of 3,000–4,000 bushes per hectare in the west and very high densities of 10,000 bushes per hectare in the east. More than 75% of sampled plots in the Karstveld areas fall in either the “very high” or “high” density category (De Klerk, 2004). The main encroacher species in these areas is *Dichrostachys cinerea* (or Sickle Bush), which occurs in densities up to 10,000 bushes per hectare. The area is also subject to relatively high rainfall, on average 550mm per annum, which also contributes to the high density of encroacher bush.

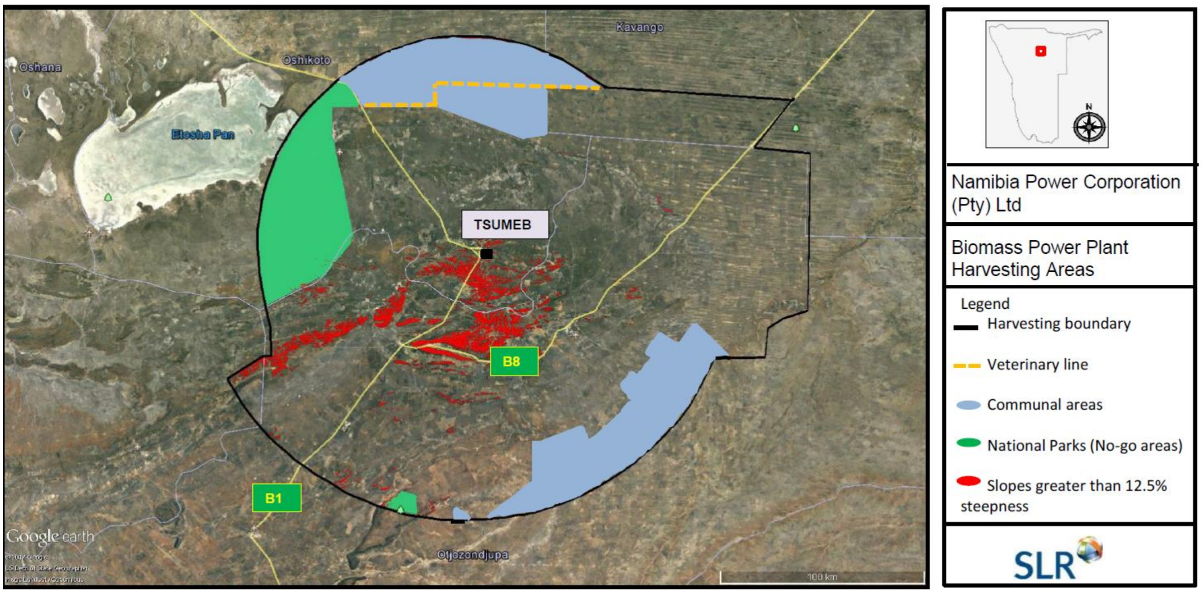

Figure 4: Proposed Harvesting Area

The proposed harvesting area is defined as a radius of approximately 100km (approximately 3.7million ha), which is extended to include the similar bioclimatic envelope beyond this boundary as shown in Figure 4, around the power station, with "no-go" areas marked off for areas north of the veterinary cordon fence, steep sloping areas, national parks and communal farmland. Seeing as many farmers are motivated to increase the carrying capacity of their rangeland, it is expected that harvesting can take place close to the delivery point. Based on an average harvesting density of 12.65 tonnes per hectare (Smit *et al.*, 2015), on a dry matter basis, it is estimated that 46.7 million tonnes of biomass can be harvested from within the demarcated harvesting area. The largest annual fuel requirement for any of the proposed scenarios is 257,391.60 tonnes, suggesting only 13.8% (core scenario: 13.2%) of the initial resource will be utilised over the lifetime of the project – without any consideration for regrowth.

Aftercare will be essential to increase and maintain the livestock carrying capacity of agricultural land.[1] If left untreated, encroacher bush can proliferate after first-time harvesting, re-coppicing from the rootstocks and remaining stumps, while some species of encroacher bush, such as Sickle Bush, are particularly prolific, and tend to regrow over a short time period, and can result in land that is even more encroached than before the initial harvest. Additionally, saplings do not present sufficient wood yield to attract large scale biomass harvesters. This thinner woody material, typical of recent re-growth, is also less suitable for conversion into woodchips for fuel purposes.

[1] Figures provided by N-BiG suggest this aftercare will cost approximately NAD200 per hectare every three years.

Competition for Resource

At present, there are a number of players in the immediate value chain for biomass, including farmers whose land is to be thinned of encroacher bush, harvesters, who thin the encroached land and produce woodchips and other biomass products, and the consumers of the biomass products including charcoal producers, firewood producers or potential biomass power stations and heating plants. The interaction between these players depends heavily on price, including the cost to the farmers for restoring the land, the cost to harvesters of harvesting the land and producing woodchips or similar, and the cost to charcoal, firewood or electricity producers incurred in purchasing the biomass input products. In this regard, the biomass suppliers who are able to harvest most efficiently at low cost are at a distinct advantage.

With regards to chipped biomass, the most likely direct competition in the region will be from the Ohorongo Cement factory. This facility is within the 100km radius of the proposed Otjikoto power station and currently purchases woodchips directly from biomass harvesters, requiring up to 85,000 tonnes of dry wood chips per annum for its multi-fuel kiln at the power station (IDFC, 2017), when the demand for cement is high. The facility uses both biomass and refuse-derived fuels (specifically waste with high calorific values), in an effort to reduce reliance on imported coal. Producers are paid to deliver woodchips to the factory gate, subject to quality control, while most of the refuse-derived fuel is provided by Rent-A-Drum.

Most of Ohorongo's woodchips are harvested within a 75km radius of the cement factory which overlaps with the Otjikoto power station's proposed harvesting area. However, the fact that a maximum of 13.8% of the total encroacher bush resource within the proposed harvesting area is expected to be harvested over the project lifespan of 25 years means that competition will likely be minimal, and the combined demand from Ohorongo Cement and the NamPower biomass power station may well provide desirable economies of scale for harvesters. Demand for bush thinning services in the region is expected to remain high for the foreseeable future due to the agricultural benefits and relatively low all-in costs, when compared to other bush control alternatives such as arboricides.

Rural and informal households in the Otjikoto region are also large users of biomass, specifically as an energy source in the form of firewood for heating and cooking (Birch and Middleton, 2017). However, this is not limited to encroacher bush, but also deadwood and non-encroacher species. Current estimated usage of biomass as firewood currently amounts to 550,000 tonnes per annum (Development Consultants for Southern Africa, 2015). Approximately 160,000 households nationally rely on firewood as an energy source, such as for cooking. Given that 40,000 private households are situated in the Otjikoto region, an upper limit of 137,000 tonnes per annum, or 7.4% of the local resource will be harvested over the 25-year project lifespan of the power station in the Otjikoto region. Care must thus be taken not to remove all sources of firewood close to informal settlements or households' dependent on firewood as an energy source.

Charcoal Harvesting Areas in Namibia

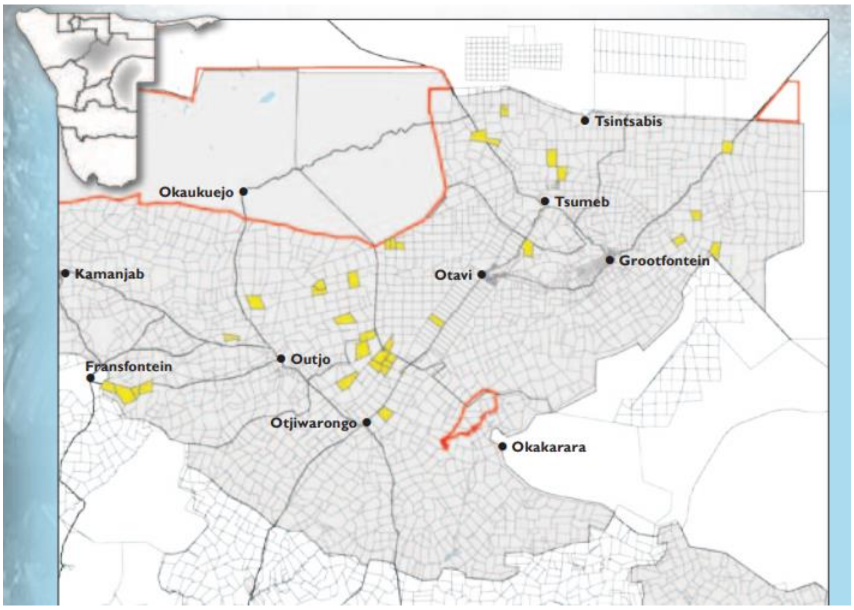

Figure 5: Charcoal Harvesting Areas in Namibia

Another large user of encroacher bush is the charcoal industry. According to Dieckman & Muduva (2010), 490 producers are registered members of the Namibia Charcoal Association. WSP (2012) indicate there are an estimated 4,800 charcoal workers operating in Namibia. The charcoal industry has been operating for more than 30 years and is currently the largest off-taker of biomass in the country. The Tsumeb, Otavi and Grootfontein area is one of the main charcoal producing areas in the country. Upwards of 72,000 tonnes, of the 121,000 tonnes of the national output, are produced in this area. The abundance and density of encroacher bush, and unskilled labour (mostly from the Kavango region), has made harvesting in this area relatively attractive. It is estimated that charcoal production requires about five times the weight of raw wood to produce the final product, using the traditional conversion technology, which would imply that around 360,000 tonnes of biomass is required for this industry in the proposed harvesting area for the power station. This equates to approximately 21.4% of the current resource in the proposed harvesting area over the 25-year lifetime of the power station. The GIZ BCBU project notes that output is expected to increase to 400,000 tonnes nationally, if production is modernised. The charcoal industry will likely remain the largest biomass off-taker in Namibia. Charcoal production releases greenhouse gases, both in its production and end-use, and so has a considerable impact on emissions.

Based on the conservative estimates outlined above, around 53% of the resource will remain unused despite harvesting for the power station. This assumption also considers no resource regrowth. Thus, the supply of the resource will far exceed the demand for the resource, meaning that competition will revolve around optimal harvesting locations (based on density and proximity to the resource off-takers), rather than for the resource itself. Competition for the resource will likely be limited, and would only arise in securing off-takers of the product, as commercial harvesters would need to ensure they have a reliable market for their product.

In conclusion, the current and anticipated demand for biomass in the area surrounding the proposed power station is expected to remain substantially below the potential biomass available in the area, despite highly conservative (i.e. 100% over-lap of harvesting zones and above current offtake levels)[2] assumptions pertaining to potential competitors for the resource.

Market Structure

Long-term supply contracts with independent harvesters or a harvesting association will be required for the security of supply of material to the power station. A secure supply would be essential to the operations of the power station, seeing as it will likely be a baseload power station.[3] Thus, reliance on a spot market would not be recommended due to the risk of fuel shortages. However, opening a spot market for independent producers to supplement stockpiles may be considered when harvesting conditions are favourable, or stockpiles of fuel start to run low. The possibility of supplementing this supply with a spot delivery market may, however, exist. This spot market need not necessarily exist at the power station but may make use of an offsite depot or farmgate pickup operators, who act as intermediaries between harvesters and the power station. It is advised that long-term contracts should include an escalation clause in line with inflation to compensate the increasing costs of labour, pump price of diesel and maintenance.

The Environmental Investment Fund (EIF) has indicated that a reliable business model and a dedicated off-taker is imperative to securing concessional financing, which is sourced from the French Development Agency and made available to harvesters via the commercial banks. This type of financing is generally provided at rates below those available from commercial banks and other commercial financiers. That being said, commercial financiers would also require a similar model in order to offer financing.

Multi-year supply contracts are likely to be critical for suppliers as they will enable harvesters to secure financing for equipment off the back of the offtake commitment for the product. As indicated under the methodology, the upper price point will likely be the only one attractive enough to attract commercial harvesters. However, business models will vary widely from harvester to harvester and it is entirely plausible that harvesters will be willing to accept lower price points.

Power Station

The modelling for the power station is based on assumptions provided by NamPower. The core scenario assumes a 40MW grate-fired power station which will be operated at a load

[2] This assumption is the most conservative assumption that can be made, and implies that there is the greatest possible competition for the region’s biomass resource. Despite this, there is still ample supply of biomass for all users in the area.

[3] The power station has baseload capability, but will likely be utilised as mid-merit to baseload.

factor of 70%. These inputs translate to 245,280.01MWh units of energy being produced annually, with an annual fuel requirement of 201,369.67 tonnes of biomass.

NamPower further indicated that prices had been estimated considering future construction costs for the power station, and thus prices were not inflated for future values.

As per our assumptions, all costs are escalated at the general level of inflation, which we assumed to be 5.5%.

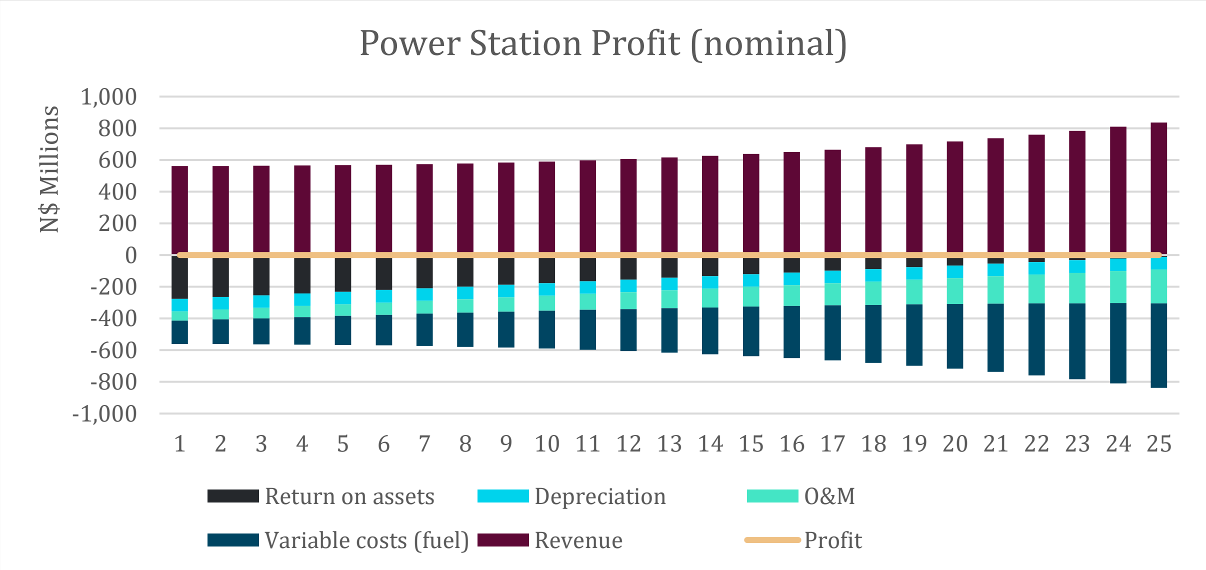

Figure 6: Power Station Profit After Tax - Nominal

Harvesting

Based on a 12.65 tonnes/hectare sustainable harvesting yield and power station load factor of 70%, it is estimated that the harvesters will thin 15,919 ha of farmland per annum. Over the full 25-year period, this totals 397,964 hectares of bush thinned land. It is assumed that aftercare will be applied to bush-thinned areas every three years to ensure that land that has been thinned is not re-encroached. It is further assumed that despite these efforts and despite on-going aftercare, some regrowth of bush will recommence 20 years after the initial harvesting.

It is assumed that harvesters earn revenue from the price per tonne received for all biomass delivered to the power station, paid by NamPower. The previous study (2018) assumed a bush-thinning fee estimated at NAD300/ha, for their value adding activities, to be paid by the landowner. This 'clearing fee' assumption has been abandoned and no longer forms part of the assessment. This improves the profitability and cashflow for farmers, however decreases the same for the harvesters. It is expected that the landowner will be responsible for aftercare. Assumed aftercare consists of manual application of arboricides to the stumps of harvested bush and is assumed to cost the landowner NAD200/ha, in 2020 value terms, every three years, following the initial harvest. The biomass delivered to the power station is to be of particle size P100. This means that the bulk of the biomass particles (minimum 75%) are to have dimensions between 3.15mm and 100mm, with a maximum of 10% of particles allowed to be oversized (between 125mm and 350mm).

The equipment and staffing costs and quantities used for this review were extracted from the prior macroeconomic study.

A production unit is estimated to be able to produce 48,000 tonnes of chipped biomass per annum and requires a crew of 20 to operate. The fuel is produced at a P100 size standard.[4] The diesel consumption for this type of machinery is expected to be in the region of 2,200 litres per day. Although very capital intensive, this harvesting unit is by far the most efficient and requires very little manpower to harvest a large amount of biomass.

It has been assumed that machinery and equipment have fixed useful lives. Machinery is purchased new and depreciated fully over their useful lives. A zero-salvage value has been assumed for machinery as there will likely be no or very low scrap values.

The fully mechanised method yielded the below net profits for the four price points provided. All price points except NAD450/t (the most favourable for the power station) yielded net profits throughout the operational life.

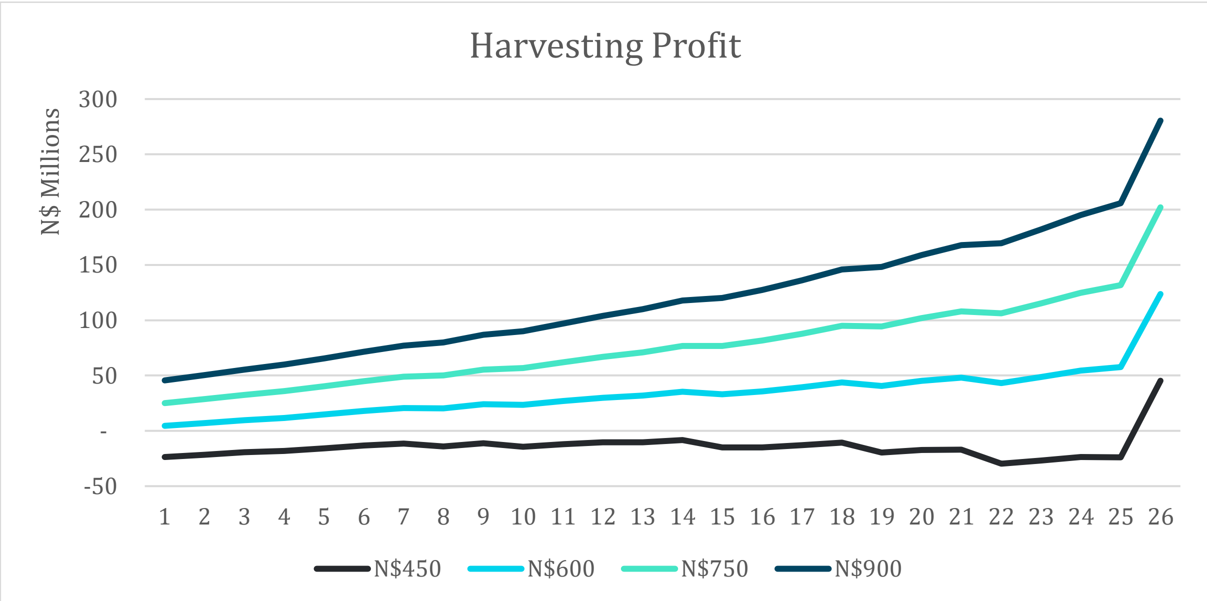

Figure 7: Harvesting Profits at Selected Price Points

[4] The numerical values (P-class) for dimension refers to the particle sizes passing through the mentioned round hole sieve size. P100 refers to a diameter of 16 – 100 mm.

Employment

Direct

The construction of the powerplant will result in a total 3,657 staff months, peaking at 239 staff months during month 26 of construction. During the operational phase of the project, the power station will employ 62 individuals: 15 skilled persons, 22 semi-skilled and 25 unskilled. The majority are therefore skilled and semi-skilled workers.

Indirect

The majority of the employment that will be created in the country and the region as a result of the power station will be indirect and/or induced employment, the former on the biomass supply chain side, and the latter as a result of increased local consumption of goods and services relating to the employment generated in the power station and related value chain. The indirect employment, however, depends on the supply-side harvesting type – the greater the mechanised component of production, the lower the employment creation.

Making use of mechanised harvesters employs fewer people, but a greater proportion of semi-skilled people relative to less-mechanized methods.

Number of people employed:

	Power station	**Harvesters**
Skilled	15	5
Semi	22	40
Unskilled	25	70
TOTAL	**62**	**115**

Table 1: Labour Requirements of Power Station and Harvesting

The estimated total wages for the harvesters and the power station are illustrated below.

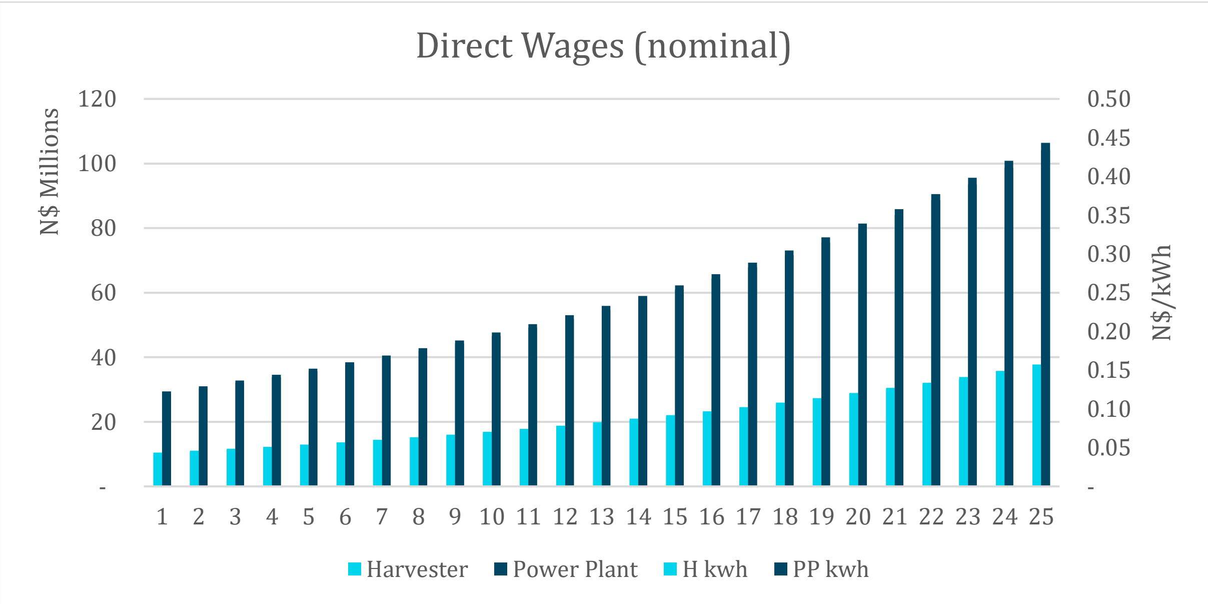

Figure 8: Direct Wages to Harvesters and Power Station Staff (in nominal terms)

Local and Cluster Development

Development and value addition activities, inclusive of indirect and induced impacts, will be focused in and around the Tsumeb area. This is due to the power station being situated just 6km from the town, with the operational staff assumed to be living in Tsumeb. Similarly, the harvesting operations are expected to occur in close proximity to the power station, moving outwards over time.

The employment impact will see relatively more low-wage earners, who are more likely to consume locally produced goods. Increased employment across all skill levels will see retailers, as well other goods and service providers, in Tsumeb benefitting.

Assuming that harvested land will be used for livestock farming, the increased livestock carrying capacity of land will result in greater demand for agricultural inputs, such as animal feeds, nutritional supplements, and livestock medications and inoculations. Greater livestock numbers will also see a marginal increase in employment for farmworkers. Downstream activities will also benefit, with increased livestock production providing more opportunities for meat processing. This could see the expansion of capacity at existing abattoirs in order to manage the new output levels, thereby creating some additional employment as well.

In terms of industrial spin-off effects, increased harvesting in the area will lead to increased local support services. These would likely be in the form of increased equipment repair and maintenance services for smaller harvesting tools such as chainsaws and trolley saws. In a similar fashion the successful rollout of mechanised harvesting technologies will allow replication in other encroached areas. Should this be the case, greater demand for parts and repair for mechanised harvesters will spur the development of these specific support services, likely to be centralised close to the majority of operations.

As this project is the first of this nature and scope, significant benefits will be the spin-off in knowledge, business opportunities and transfer of skills generated. Seeing as the area already being utilised for charcoal production, the opportunity for knowledge sharing is quite high. Workers with experience in the harvesting industry will be able to drive efficiencies and increase productivity, especially using the manual and semi-mechanised methods of harvesting.

Microeconomic Impact on Agricultural Sector, Ecosystem and Environment

Agricultural Sector

Livestock farming is one of the primary land uses in the harvesting area. As a result, it is an existing source of employment and income generation in the area and region. Agricultural land in the proposed harvesting area that has been bush thinned will most likely be used for livestock farming, as land for crop farming needs to be cleared in its entirety. The primary benefits derived by the agriculture sector will therefore come from increased livestock farming, as it is the most likely use of the bush thinned land. As such, it is taken that most upstream benefits will come from an increase in livestock carrying capacity as a result of bush thinning, ultimately manifesting in increased beef production.

Several steps (outlined below) were taken to determine the benefit to agriculture, particularly livestock farming, from bush thinning. The annual hectares thinned (attributable to this project) were estimated based on the annual demand in tonnes for the power station (201,369.67t) and the average yield per hectare (12.65 tonnes/ha). This amounts to annual thinning of 15,919 hectares. Over the full 25-year period, this totals 397,964 hectares of bush-thinned land.

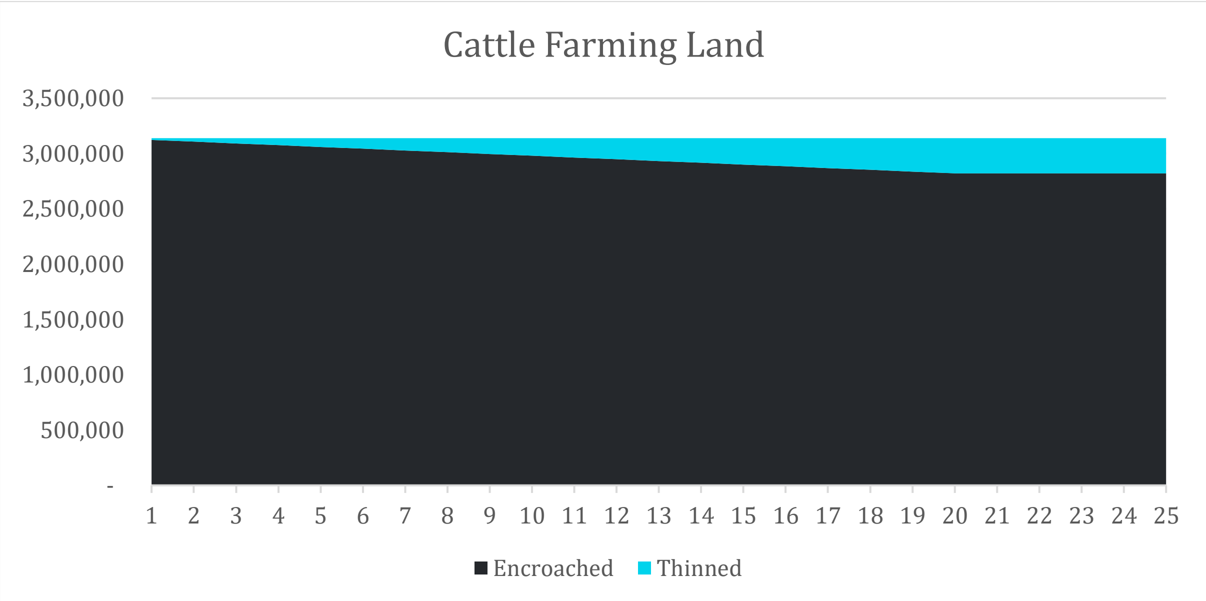

Figure 9: Cattle farming land

An initial carrying of 17 hectares per livestock unit is used, suggesting a current herd size within the proposed harvesting area of 185,000 heads of cattle, which is used as the 'business-as-usual' case. An increase of 70% (i.e. from 17 to 10 hectares per head of cattle) in carrying capacity after bush thinning is adopted from the previous macroeconomic study. The delay in reaching the increased carrying capacity is split over the preceding years in the project model. Full utilization of current carrying capacity is implicitly assumed. It is assumed the bush-thinned land is subject to aftercare (at NAD200/ha every three years), with regrowth only occurring in Year 20. While the aftercare regime should prevent any regrowth from occurring, the model incorporates regrowth from year 20 as a precaution.

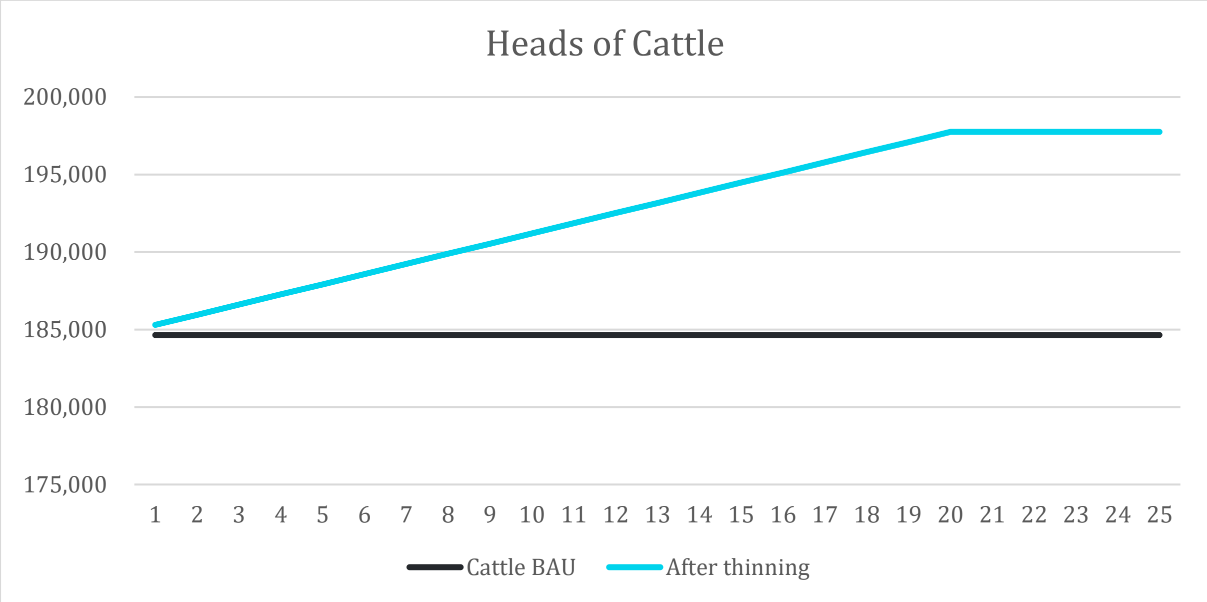

Figure 10: Heads of Cattle

The increase in livestock numbers attributable to the bush control practices amounts to additional carrying capacity of 13,109 cattle over the 25-year period.

It is assumed that marketing will only begin in Year 4, allowing for stock levels to rise and young animals to reach maturity. It is assumed that farmers will market 60% of the new animals. Of the additional cattle available for marketing, trends within the market suggest that 75% of these are to be exported (either live or through export butcheries), boosting foreign exchange earnings (detailed in the Balance of Payments section of this report).

The revenue generated by farmers from the additional livestock is calculated using the average beef producer price for 2019 (available from the Meat Board of Namibia), inflated at 5.50% per annum (well below the long-term average of 9.40%), along with a conversion factor of 250kg per head of cattle. Given the emergency marketing in 2019 necessitated by the drought in 2019 and subsequent improved rainfall, cattle prices are likely to improve significantly (and above the assumed general inflation rate) over the forecast period. This means that the results from this study provide a conservative estimate. It is assumed that the volume of cattle marketed per hectare will also increase by the same ratio as the increase in carrying capacity.

The initial benefit generated in NAD/kWh terms is negative, as input costs are greater than output during the harvesting and re-stocking period. However, from Year 8 onwards, sales from the increased carrying capacity start to outstrip costs, and the aggregate profits of farmers whose land has been bush thinned expands over the project lifespan.

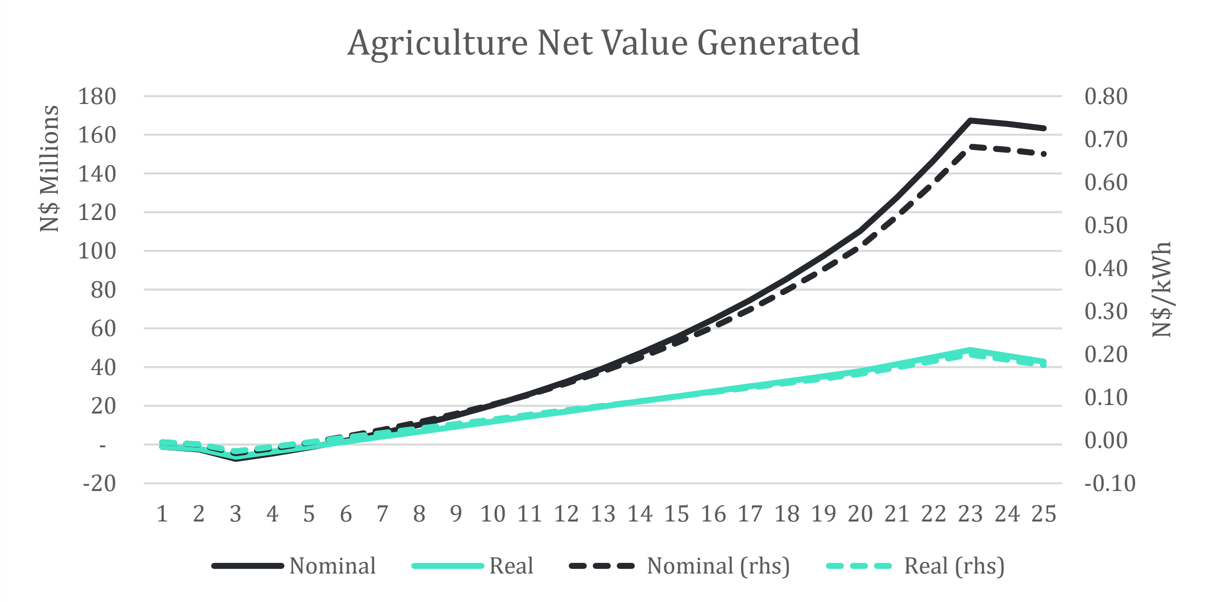

Figure 11: Net Agricultural Value Generated

The total net benefit to farmers over the 25 years, once discounted (at 5.5% p.a.) is NAD407.4 million. This value accounts for the cost to farmers for aftercare services, under the assumption that farmers payNADNAD200/ha for these services.

The average direct value addition from livestock per kWh over the 25-year lifespan of the power station, in 2018 terms, is NAD0.07/kWh, which accrues to farmers. The further benefits are to the upstream and downstream activities, such as input industries for farming (cattle feed, veterinarians) and downstream activities (such as abattoirs), increased exports, and additional workers hired as a result of larger herd sizes.

Ecosystem Services

Bush encroachment impacts a range of ecosystem services. A review in Birch *et al*. (2016), taking into account the Common International Classification of Ecosystem Services (CICES) classification, recognised three categories of services: provisioning, regulation and maintenance, and cultural. The point is made that for many of the services "there is little data or research on how they might be impacted by de-bushing". Below is a summary of the services which are expected to be highly impacted by a harvesting programme:

Category	Ecosystem Service Class	Example	Estimated direction of impact from bush control
Provisioning	Reared animals and their outputs	Beef production	positive
	Groundwater for drinking and non-drinking uses	Drinking water, non-drinking water	positive
	Plant-based resources	Charcoal and firewood production, electricity generation	positive
	Wild animals and their outputs	Game meat, skins	mixed
	Fibres and other materials for direct use processing	Materials for construction	positive
	Materials for agricultural use	Animal feed supplement	mixed
Regulation & Maintenance	Global climate regulation by reduction of greenhouse gas concentrations	Carbon sequestration	negative
	Mass stabilisation and control of erosion rates	Control of soil erosion	positive
	Hydrological cycle and water flow maintenance	Groundwater recharge	positive
	Maintaining nursery populations and habitats	Habitats for species	mixed
	Weathering Processes	Restoration of soils	positive
	Decomposition and fixing processes	Nitrogen fixing and nutrient replenishment	mixed
Cultural	Experiential use of plants, animals and landscapes	Wildlife viewing	positive
Cultural	Physical use	Trophy hunting	positive

Adapted from Birch *et al*. (2016)

Table 2: Environmental Impacts of Bush Control

For the purposes of this project, valuations are undertaken for beef production (see previous section), groundwater recharge (see next section), and climate regulation, via greenhouse gas emissions. Tourism is also discussed, although only a transfer valuation is estimated. Other areas are harder to assess, and also less relevant in some cases given that the biomass is allocated for a single use i.e. electricity generation. However, there are potential spin-off effects from the establishment of major bush thinning and offtake programmes, that could help accelerate the development of other services listed above.

Groundwater

The objective to increase groundwater resources is one of the main motivations behind bush control. Bush-encroached land places more demand on these resources than bush thinned land, due to a higher rate of evapotranspiration (Christian *et a*l., 2010). Previous studies (Birch *et al*., 2016; Birch and Middleton, 2017) by the Namibia Nature Foundation (NNF) found that the evidence was limited on groundwater recharge rates both for bush-encroached and bush thinned land. Therefore, they adopted an average recharge rate of 1% of rainfall across the country (Christelis and Struckmeier 2011) as the baseline for bush-encroached land. Studies on the impact of bush control suggested increases to between 4-8%, however a conservative estimate of 2% was applied. A more recently completed 9-year controlled study in Okahandja (Groengroeft *et al*. in press) suggests that recharge rates for both bush-encroached (15%) and bush thinned (42%) land are much higher, however we retain the NNF assumptions for this analysis, and note the likely bias to underestimate the level of groundwater resource improvement. It must be noted that the use of herbicides on agricultural land will have a negative impact on the quality of available groundwater resources, as herbicides biodegrade over a prolonged period (with a half-life of anywhere between 2-15 months for commonly used arboricides such as Bromacil or Tebuthiuron) and could leak into groundwater, thereby causing contamination.

Also noted from the NNF studies were two different approaches to valuation, in respect of the extent of increased stocks that could be valued. In the national study (Birch *et al*., 2016), the total increase in stocks were valued, whereas in the regional study (Birch and Middleton, 2017), only the increase in stocks that could be extracted by existing infrastructure were valued. The latter approach is more realistic as it implicitly assumes non-negligible investment costs to realise the value of increased groundwater stocks. It is therefore also more conservative. In place of current information regarding the existing water extraction infrastructure in the project region, we apply an accessibility ratio derived from the NNF regional study, of 10%.

The total direct groundwater increase from bush control can be calculated using the area bush thinned, and the average rainfall for the region (550mm/annum), based on climate data from Grootfontein (Petrick and Katali, 2018). Assuming no bush regrowth, and applying the accessibility ratio, the increase in extractable groundwater stocks would amount to 2.0 million m^3 per annum after 25 years, or 31.5 million m^3 in total over the time period. Before placing a value on these stock increases, there are various offsetting factors to consider.

A co-objective of bush control is to improve the carrying capacity of land, in particular with regard to cattle. For this analysis, it is assumed that all harvesting takes place on cattle farms, and that the improved carrying capacity would be utilised. This results in an increasing number of cattle, as detailed previously, and a consequent increase in demand for water by cattle. Figures provided by NamPower indicate a value of 9.13m^3 of groundwater consumed per head of cattle per annum.

The biomass power station would also use water in the production of steam to drive the turbine. The amount required has been estimated at maximum of 8m^3 per hour, which assuming a capacity factor of 70% equates to 49,056m^3 per annum, and 1.2 million m^3 over the period.

A large potential offset comes from bush regrowth. This can be avoided by the deployment of an aftercare regime. The assumptions for this study are that such a regime is followed until the 20th year, ensuring zero regrowth over this time, after which bush regrowth occurs to the extent that it offsets the impact of harvesting i.e. there is no net increase in bush thinned land during the last five years. Regrowth therefore reduces extractable groundwater stocks by 525,312m^3 over the period.

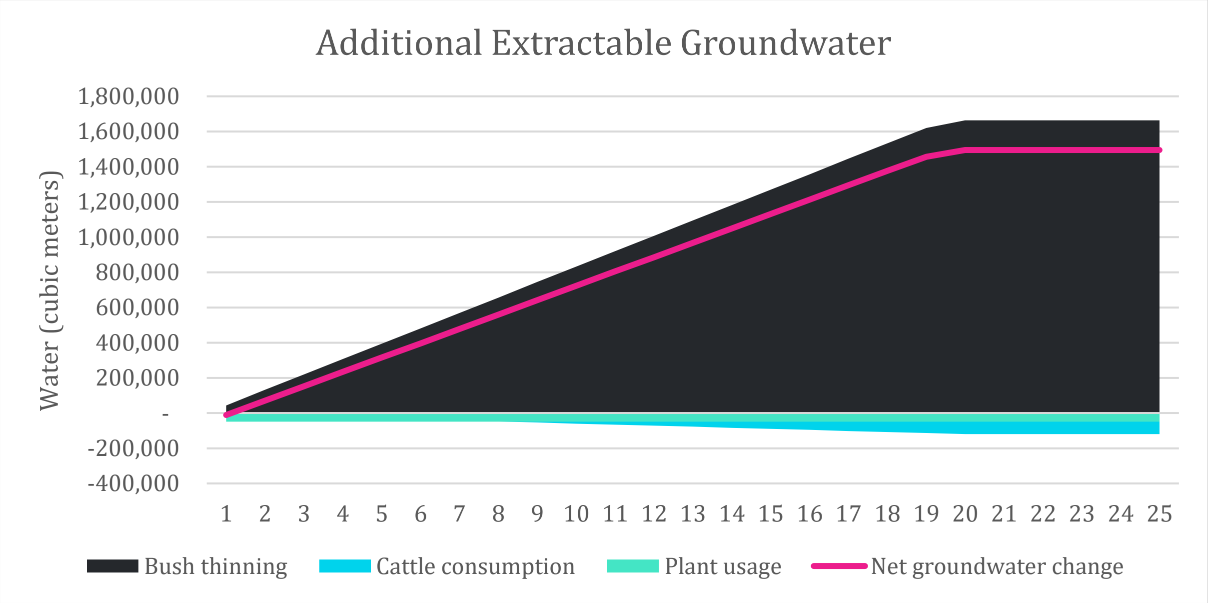

Figure 12: Additional Extractable Groundwater

Net of all offsets, extractable groundwater stocks are projected to increase by 22.7 million m^3 over the 25-year period. In order to value these stocks, we observe that the NNF studies took an avoided cost approach, obtaining an implied price for water from the Kalkfeld supply project, of NAD14.7 million per million m^3 of water, at 2015 prices. Assuming 5.5% inflation to the start of the operational period, and valuing cash flows in real terms from then on, results in a net valuation of NAD460.2 million (NAD0.08/kWh) for the increase in extractable groundwater stocks.

<u>Tourism</u>

The tourism industry is an increasingly important sector in Namibia's economy. It is based on a rich resource of landscapes and wildlife, both of which can be impacted by bush encroachment. For those with aesthetic objectives, dense bush can make it difficult to see animals, and changes the nature of the landscape. Other tourists with consumptive objectives may find reduced success, when hunting for example. There is a lack of research on quantifying the impacts of bush encroachment on tourism. The NNF regional study (Birch and Middleton, 2017) made a preliminary attempt, a summary of which follows.

The study considered both non-consumptive (wildlife viewing) and consumptive (trophy hunting and game products) aspects of tourism in the Otjozondjupa region. Revenues from wildlife viewing were hard to isolate, with only anecdotal evidence available to suggest increased tourist satisfaction, and willingness to pay higher prices for viewing animals on bush thinned land. An estimate was made that an additional NAD19.9 per hectare of revenue could be due to bush control. Based on 9,150 hectares per annum of private game farms being bush thinned, as per the NNF study, this resulted in a net discounted benefit of NAD22.7 million over 25 years. Increased costs were not estimated, but were expected to increase in line with the expectation of more visitors.

Trophy hunting and game products provide larger baseline amounts of revenue to conservancies and private game farms. The perception within conservancies was that bush encroachment did not have a significant impact on hunting or game stocks, therefore the analysis focused on private farms. Assuming a 50% carrying capacity increase (from a 30-80% evidential range) due to bush thinning, an attempt to model the sustainable stock increase was made. Based on 1.25 million hectares of existing farms, additional revenue of NAD135.2 million per annum was estimated. Adding new farms, based on a 10% capacity expansion, led to an estimated NAD33 million per annum, for a total discounted benefit of NAD1.1 billion over 25 years. Such a benefit requires significant investment to realize, and the associated costs were estimated at NAD882 million, for a net benefit of NAD202 million.

The study area assumed a bush thinning rate of 316,000 hectares per annum, with a weighted density reduction of 38.5%, so effectively 121,500 hectares per annum of bushed thinned land. This is ~20x the area to be bushed thinned per annum in this project, so a naive calculation, assuming all conditions are equivalent, suggests potential tourism benefits in the project region of NAD10 million (NAD0.003/kWh) over the 25-year period. Given the assumed utilization of all harvested land for cattle farming elsewhere in this analysis, this figure should only be considered for comparison, rather than as an addition to the value of the project.

Environmental Impact

The environmental impact of the project analysed the various impact assessments as part of the detailed assessment completed in 2020. The baselines and key considerations are briefly outlined, which may give rise to arguments for further costs and/or benefits to be evaluated. Greenhouse gas emissions will be addressed in the subsequent section.

The following sections are based on the draft EIA Report (Petrick and Katali, 2017), commissioned for the project.

Biodiversity

The harvesting area has high levels of plant endemism, and high diversity levels for plants, birds, amphibians and mammals. Five identified bird species are on the Red Data list, and two are Globally Threatened. In total, eight bird species are regarded as being at potential risk from the project development, with breeding birds deemed especially vulnerable. Assessments of the potential for disturbance or destruction could form the basis for existence value calculations. The area is suitable as a Black Rhino habitat, although for security reasons, no numbers are available. Regardless, the economic impact of any disturbance, or increase in poaching, both in terms of existence value and tourism impact, could be significant. Potential improvements in biodiversity from bush thinning, and rangeland improvement are explicitly valued in the groundwater and agriculture sections.

Water

Contamination potential exists for both surface and ground water from hydrocarbons at the power station and from transport, such as oil and chemical spillages, ash, and water treatment activities. Any such occurrence would have direct and indirect economic impacts. Run-off is likely to increase to farms, dams, rivers, which is positive in a Namibian context, but could also increase erosion impacts on steeper ground. The positive impacts likely due to recharge rate increase are evaluated in the previous section.

Air Quality and Third-Party Health

Baseline pollution sources in the region include: Namibia Custom Smelter (in Tsumeb), cattle farming, crop farming, and dust from unpaved roads. Furthermore, the potential exists for early morning pollution impacts at Tsumeb from night-time westerly winds. Evaluation through the Environmental Impact Assessment (EIA) suggests that the increases in pollution from the power station, limited to best internal standards and guidelines, has no significant impact and thus is considered acceptable with the mitigation measures proposed.

Noise

Baseline noise levels were measured at two farms, both within 2km of the proposed site, and deemed to be relatively high due to traffic and farm noise. Levels are likely to increase from power station and harvesting activities, but with limited impacts on the local population.

Visual

The project site area is covered in medium to tall bush, and there are mining and quarrying activities in the surrounding area. The visual value has been assessed as moderate. No residential or tourist sites occur within the study area, so the aesthetic impact of the power station is likely to be minimal, although harvesting and transport activity may be more exposed.

Traffic

The site is situated adjacent to the Trans-Kunene Highway Corridor and would require some geometric upgrades. The increased traffic, particularly large, bulky vehicles will likely cause road safety issues. Road surface conditions are likely to be impacted from the heavy vehicle flow transporting woodchips. These factors add up to some potentially significant economic impacts that will need to be addressed.

Greenhouse Gas Emissions

Burning biomass to produce electricity, impacts greenhouse gas emissions in several ways, with varying degrees of clarity. Different accounting procedures for these emissions can fundamentally change the outcome, so we set out our assumptions with regard to the most important aspect first. On burning, the carbon that was stored in the woody biomass over the growth period is released as carbon dioxide. At that point in time the emissions factor per unit of energy can be similar to that of coal, and perhaps even larger due to higher water content. However, established procedure adopted for instance by the EU Renewables Directive 2009, assumes that the carbon dioxide emitted will be compensated by that captured during plant regrowth (EC, 2016). As mentioned in WSP (2012), “the carbon dioxide released during this process is termed biogenic carbon, and as it forms part of the short carbon cycle, is not considered to have a significant impact on long term carbon stocks”. This can be controversial when considering biomass derived from forests with long growth cycles. However, given that encroacher bush is typically fast growing, particularly in the case of Sickle Bush, which dominates in the project area, this approach can be justified. It should also be recognised that the amount of biomass required for this project will likely not prevent net growth in stocks of encroacher bush nationally, or even regionally, and the sequestration capacity that this entails. With this net zero emissions assumption from biogenic carbon, the focus therefore is on emissions from the supply chain and land use change.

Supply chain emissions include harvesting, transport and conversion processes. Emission factors measured in Kilograms of Carbon Dioxide equivalent (TCO_2e) per megawatt hour (kWh) were estimated for a project of this type in WSP (2012).

GHG emissions ($kgCO_2e$) per kWh of electricity generated		
Harvesting	9	17
Infield Transport	1	
Handling	2	
Road Transport	5	
Conversion	15	15

WSP (2012)

Table 3: GHG Emissions ($kgCO_2e$) per kWh of Electricity Generated.

Using data provided for the project, the fuel expended for transport is in line with these estimates, however for harvesting, the use of mechanised methods will incur an emissions factor of 1.5-2 times higher than those estimated. For conversion, which essentially is power used to run the power station, we adopt the estimate provided. These factors produce supply chain emissions of ~130,000 TCO_2e over the 25-year period.

Land-use change can be considered in two ways. The first concerns soil organic carbon, and the impact of transitioning from encroacher bush to savannah. To date, studies have rather focused on the transition from savannah to encroacher bush, as this is the typical direction of change. We are therefore limited to adopting the assumption that taking the negative value of observed effects is a valid approach. A paper by Blaser *et al*. (2014) found a range of results from 15 studies across 21 locations, mostly in the US, with a mean value of $21gC/m^2$ for the impact of transition to encroacher bush, although with a wide range between $-80gC/m^2$ and $239gC/m^2$. The authors also conducted their own study on Sickle Bush encroached areas in Zambia and found a range of $12\text{-}16gC/m^2$. This is the same species type as present in most of the project area, so it gives some reassurance that adopting the mean study value has some validity. Namibia has very low levels of soil organic carbon, so the NNF studies made the assumption that "the capacity of the soil to sequester carbon is only reduced in the first year of de-bushing, rather than annually". Applying the negative sequestration figure to the annual bush thinning volumes, net of regrowth, results in ~123,000 TCO_2e over the 25-year period.

The more recent greenhouse gas emissions study (UNIQUE, 2019) found that bushland with similarities to the proposed project area results in 14.5 tons of carbon sequestered annually, and when including soil organic carbon, this increases to 17.1t C/ha. However, the assumptions in the UNIQUE's (2019) electricity generation scenario are materially different: it assumes removable biomass of 17.1t wood/ha and a livestock restocking post harvesting increasing by 213%. This study found that total GHG emissions over a 20-year period of 12.57 tCO_2e/ha. With the 40MWe power station resulting in 485,971 ha being thinned over the 25 years, the UNIQUE (2019) figures suggest total emissions of 6,108,651tCO_2e. The figures from the UNIQUE (2019) study are not used in this report, given the different underlying assumption, thus we have updated the results from the 2018 Cirrus report to match the updated scenarios for the 40MWe power station, amongst others.

	Emissions over 20 years (tCO2e/ha)
Removal of wood	29.43
Regrowth with aftercare	-1.56
Arboricide application	0.03
Average soil emissions	-6.56
Livestock	4.63
Harvesting & chipping	0.3
Transport	0.9
Substitution of fossil fuels	-5.6
Total GHG balance	**12.57**

Table 4: Emissions Results - UNIQUE 2019 GHG Study

The second consideration for land-use change is the impact of improved carrying capacity, and the utilisation of it by increasing numbers of cattle. The effects can be significant given that cattle emit methane, which has a GHG potential ~30x greater than CO_2. The following sources included in the NNF studies provides an estimate of emissions per additional head of cattle per annum:

Estimate of CO_2e emissions / Head / Annum from Additional Livestock	
Average liveweight (kg)	297
Emissions per kg liveweight (kgCO_2e)	11.93
Convert to tonnes from kg	0.001
Additional Emissions (kgCO_2e) per Head	3543.21

NNF (2015)

Table 5: Estimate of CO_2e Emissions / Head / Annum from Additional Livestock

Applying this figure to the cumulative increase in cattle as modelled for this project, results in additional emissions of ~720,000 TCO_2e over the 25-year period.

Alternative land use scenarios could be considered, for example switching to a mixed model with game and tourism, as well as cattle farming. This would likely be much less directly emissions intensive, however the secondary effects of increased tourism, with associated air miles, could offset or outweigh, on a macro scale, the reduced emissions from cattle.

To summarise the supply chain and land-use change emissions, we have the following:

Activity	**kgCO_2e over 25 Years**	**kgCO_2e / kWh**
Harvesting*	136,041,996	0.022
Transport	12,529,000	0.002
Conversion	91,980,004	0.015
Soil Carbon	233,190,858	0.038
Livestock	719,955,470	0.117
Total	**1,193,697,327**	**0.195**

Table 6: Supply Chain and Land-Use Change Emissions

One of the motivations behind the project is for Namibia to become more self-sufficient in electricity. Current domestic generation satisfies less than half of demand, with the remainder being imported from neighbouring countries, predominantly South Africa. Namibia produces electricity with a very low emission factor of around 50 kgCO_2e/kWh, due to the large proportion coming from the Ruacana hydroelectric power station. However, on a grid-level basis, including imports, the emission factor is around 10 times higher, due to the reliance of South Africa on coal powered generation. WSP's Prefeasibility Study (WSP, 2012), used the grid level factor of 489.8 kgCO_2e/kWh. Analysis of current energy sources as stated in the NamPower 2017 Annual Report (NamPower, 2017) suggest a figure of around 500 kgCO_2e/kWh is still relevant today. Furthermore, a reasonable case can be made that any new generation capacity would be expected to specifically displace imported power. A UNFCCC (2013) baseline study for projects within the Southern Africa Power Pool (SAPP) acknowledges this approach, and establishes a grid emission factor of 964.4 $kgCO_2e/kWh$, for any new generation capacity to be measured against.

	$kgCO_2e$ over 25 Years			
Grid Emission Factor	**Emitted**	**Displaced**	**Project Net**	**Per kWh**
Namibian Grid = 489.8 (WSP)	1,193,697,327	-3,003,453,717	-1,809,756,390	-0.24
SAPP = 964.4 (UNFCCC)		-4,258,060,966	-3,064,363,639	-0.41

Table 7: Kilograms of carbon dioxide emissions over 25 years

A note of caution with regard to applying the SAPP grid emission factor over the whole period is that it largely assumes South Africa will remain almost entirely dependent on coal power generation over the next 25 years. It is more likely that renewables will increasingly come online, leading to a decline in the factor over time. It is therefore prudent to use the Namibian Grid factor, although this will decline commensurately, as a basis for emissions value calculations.

	Value of Net Emissions at Beginning of Operational Period
Carbon Price	**NIRP NAD85**
NPV NAD	149,722,174.84
NAD/kWh	0.06

Table 8: Value of Net Emissions at Beginning of Operational Period

Summary of Microeconomic Benefits

The aggregate microeconomic impact of the proposed power station is made up of direct payment of wages and salaries, agricultural benefits in the form of livestock production and the improvement of groundwater recharge from thinning bush-encroached areas, reduced CO_2 emissions, increased domestic electricity production and value addition derived from biomass harvesting.

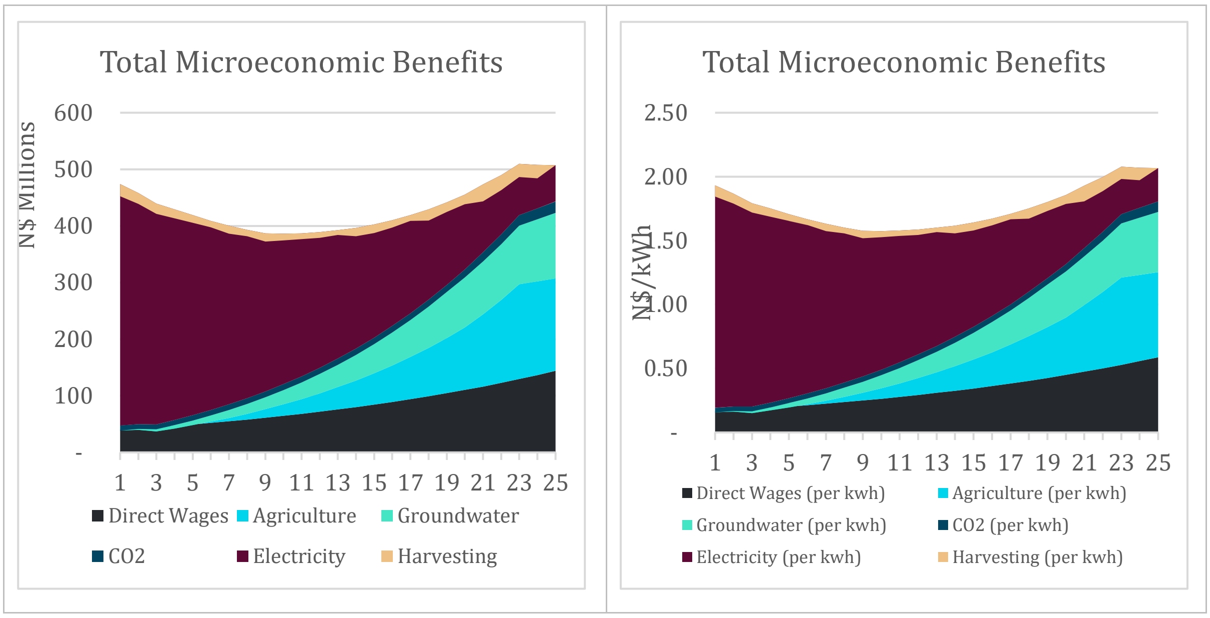

Figure 13: Total Microeconomic Benefit

In net-present-value terms (discounted at 5.5%), the aggregate value of gross value addition for our core scenario is NAD4.965 billion that would otherwise not take place were it not for this project, or NAD0.81/kWh.

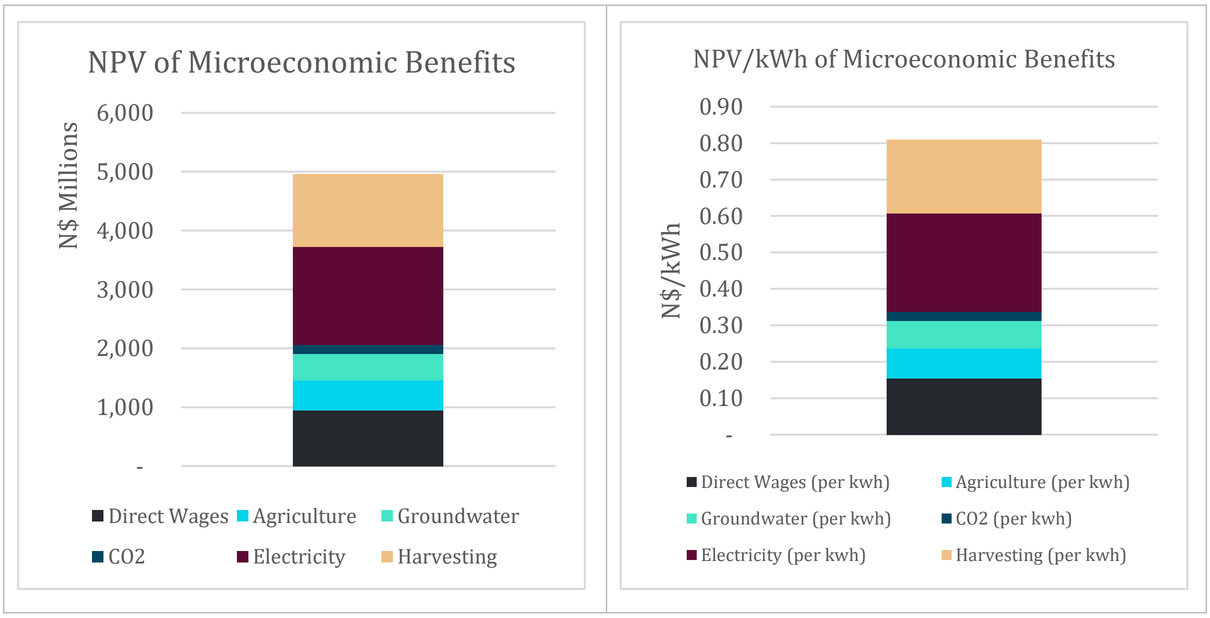

Figure 14: NPV of Microeconomic Benefits

Macroeconomic Impact of the Project

Contribution to GDP

Direct

The direct contributions to GDP from the project will be seen both during the construction and the operational phases of the project. The construction phase will see the greatest short-term addition to GDP, while operations will provide a smaller but longer-lived contribution.

Construction

The total project cost is estimated at NAD2.7 billion, which includes the CAPEX, contingency and development cost for the base case scenario selected. From a GDP perspective, imports register as a negative in the value-addition calculation, while only gross value addition (output less intermediate consumption) on the remainder of the construction activity forms a direct positive contribution to GDP.

In the construction sector, the ratio of gross value addition to total output varies from 28% to 32%, as illustrated below. Over the past 10 years, the ratio has averaged approximately 30%, which is the assumed ratio for this project. As a result, the direct construction phase value addition from this project is assumed to be NAD797.2 million.

NAD Million (2020 dollars)	**2021**	**2022**	**2023**
Output	797.20	1062.94	797.20
Intermediate consumption	558.04	744.06	558.04
Value added, gross	239.16	318.88	239.16

Table 9: Direct Construction Phase Value Addition

Operation

During the operational phase, the direct contribution of the power station will be two-fold when compared to the status-quo, assuming that the power generated is offset against what would otherwise be power imported from the region. In this regard, power generated would constitute one portion of the direct contribution to GDP, while the reduction in imports would be a second contribution.

The price paid by NamPower for biomass will be a large determinant of intermediate consumption cost for the contribution to GDP of the power station, and thus the GDP contribution of the power station. The higher the input (biomass) cost, the lower will be the direct contribution to GDP, although the inverse is true when it comes to biomass producers and their contribution to GDP. The contribution to GDP also varies from year to year over the 25-year life expectancy of the power station. As a result, depending on the year, and depending on the price paid for biomass, the power station will generate electricity worth between -0.05% and 0.21% of GDP per year.

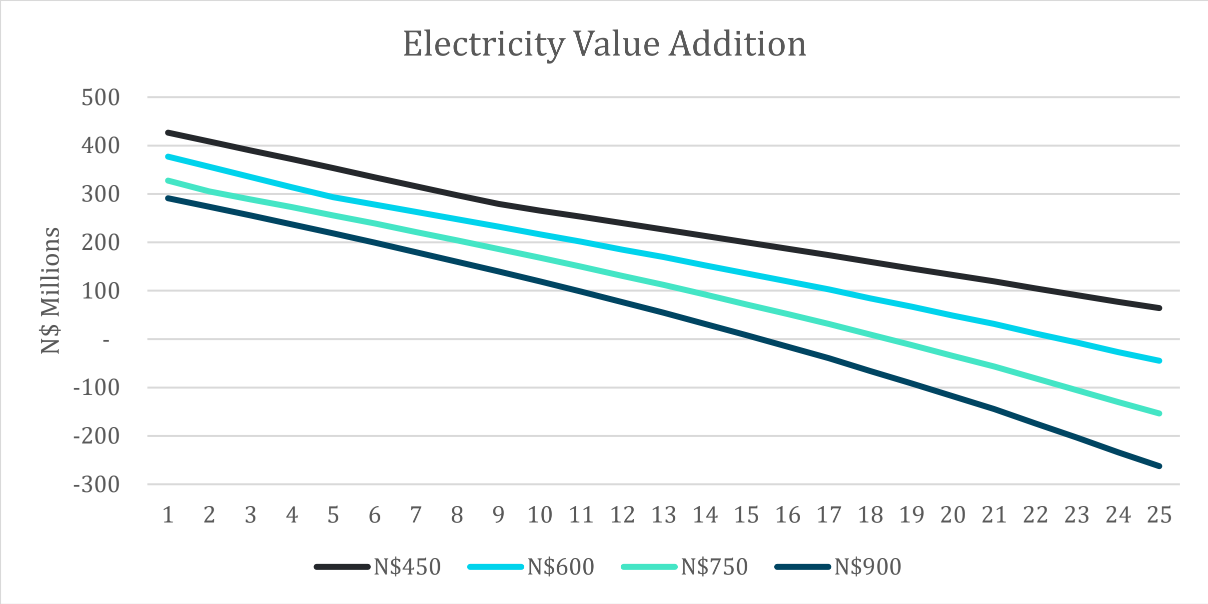

Figure 15: Electricity Value Addition, Gross

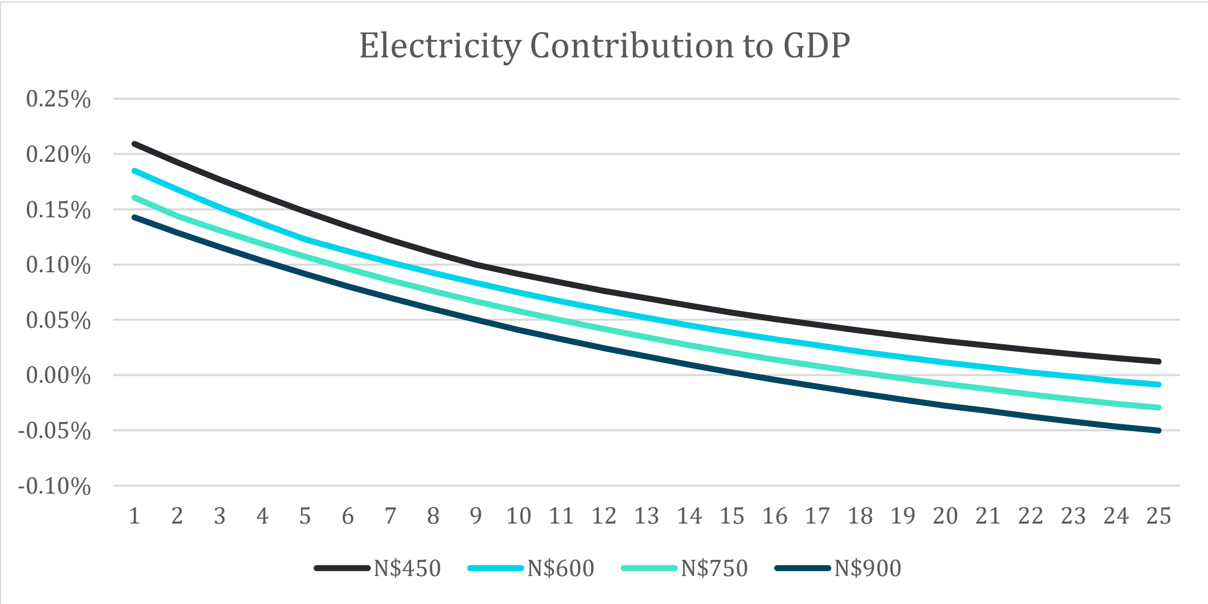

Figure 16: Electricity Production, Contribution to GDP

The negative contribution implies that the cost of power production is greater than the revenue that is generated there-from, meaning that the net effect on GDP would be negative.

Additionally, the reduction in imported electricity will contribute between 0.14% and 0.24% of GDP over the 25-year life expectancy of the power station.

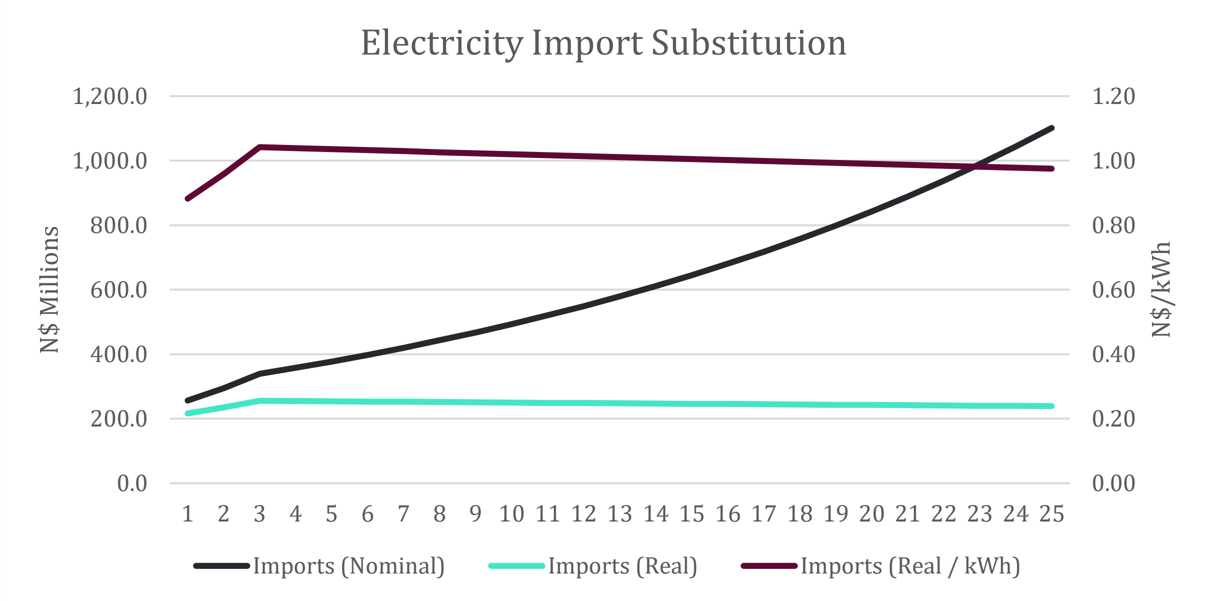

Figure 17: Electricity Import Substitution

The electricity import substitution has been assumed to predominantly replace Eskom energy. The make-up of the imports largely depends on the time-of-use and specific power supply agreement which may be offset at the given point in time. This assumption based in net present value terms, the electricity value addition over the project lifetime is illustrated in the table below at each of the respective price points, as well as the impact of reduced electricity imports.

Electricity Value Addition	**NPV of Benefits (NAD 2018 Dollars)**	**NPV / Total kWh**
450/tonne	3,668,172,309	0.60
600/tonne	2,838,995,945	0.46
750/tonne	2,072,597,360	0.34
900/tonne	1,351,010,205	0.22
Import Substitution	7,150,437,842	1.18

Table 10: Net Present Value (NPV) of Electricity Value Addition

<u>Indirect</u>

The indirect contribution to the economy is viewed, primarily, to come from two sources. These are the biomass industry, as well as the increase in agricultural output expected from the bush thinned land and rangeland restoration (as outlined earlier) associated with biomass harvesting. The downstream benefits of the energy production are assumed to be net-neutral on the Namibian economy, as the locally produced power is merely a substitute for imported power, not power that would otherwise not exist. Therefore, apart from the upstream benefits, no direct downstream benefits are assumed.

Biomass

The direct contribution of biomass to GDP depends on the sales price of biomass to NamPower.

The greatest contribution to GDP from harvesting is seen when the price per tonne of biomass is set at NAD900. In this scenario, the contribution to GDP from the biomass supply chain varies from 0.08% to 0.12% over the 25-year lifespan of the power station. At NAD750/tonne, the contribution to GDP varies from 0.05% to 0.08%.

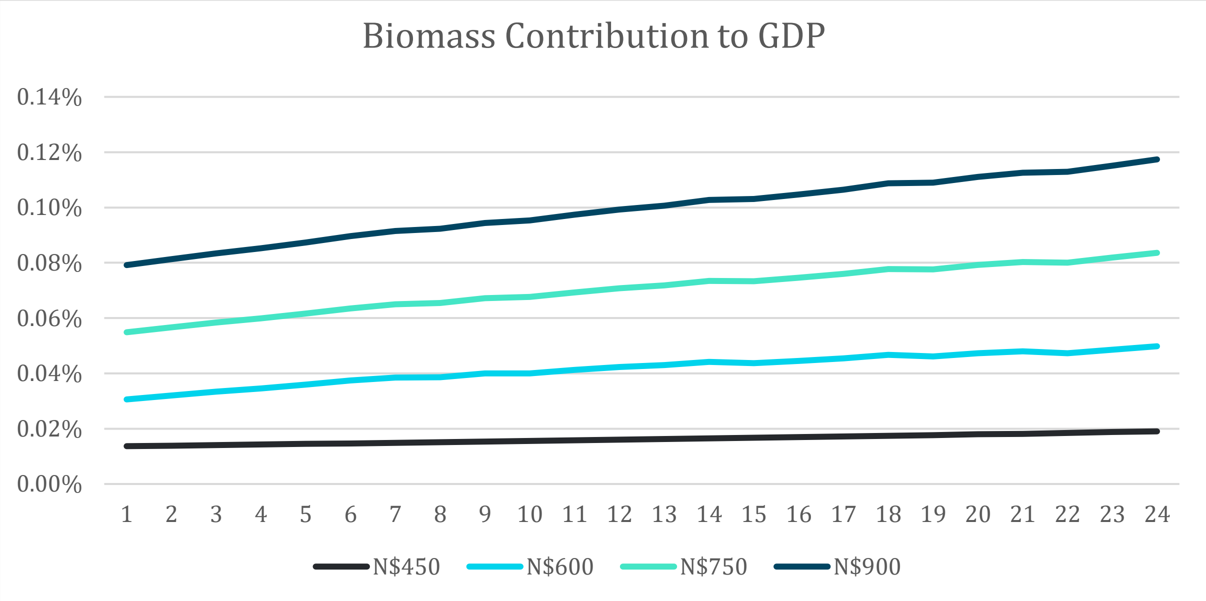

Figure 18: GDP vs Price-Point Sensitivity

The value addition profiles, and thus the contribution to GDP varies across the scenarios due to the revenue generated by the harvesters, which is dependent on the price per tonne of biomass (as the volumes are fixed

Agriculture

The proposed power station will have a profound impact on agriculture as bush-thinned land will increase the carrying capacity of the commercial farmland in particular. For this study, it is assumed that all thinned land will be used for agricultural purposes - particularly livestock farming - and all alternative land-uses are not considered. The reason for this is that it is assumed that the base-case scenario for farmers in the area is to increase livestock numbers as the carrying capacity on the land increases as a result of rangeland restoration. In the event that farmers undertake agricultural activities other than livestock farming, it is assumed that this will be done only because the potential returns from such activities are greater than would be the return from livestock farming. This is to say that the base-case for value addition is captured in the assumptions made, and any deviation away from such can be expected to yield greater long-term return for farmers and thus the local economy.

Over the 25-year lifespan of the power station, the increased contribution of agriculture to GDP is expected to peak out at approximately 0.039%. This is the point at which agricultural output peaks and is based on the assumption of aftercare being applied every three years.

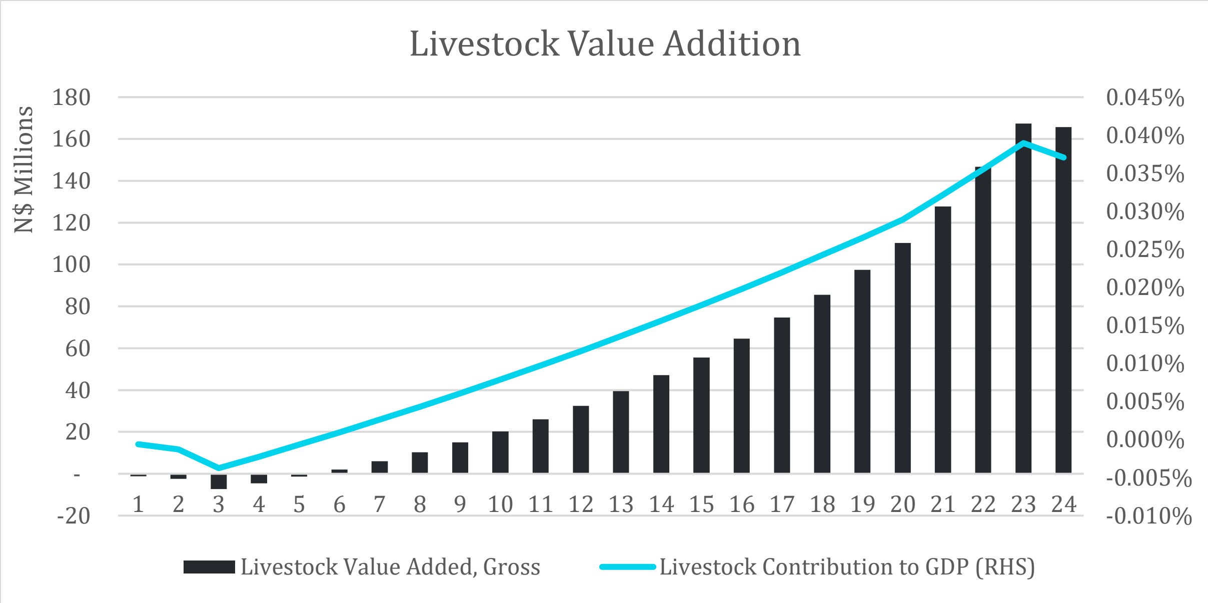

Figure 19: Additional Livestock Contribution to GDP

<u>Multiplier Effect</u>

GDP multipliers were extracted from the Namibian Social Accounting Matrix (SAM) of 2013 (Schade, 2016; Lange and Schade, 2008) and applied to the output of the microeconomic modelling exercises. Multipliers from the SAM were adjusted as necessary to avoid double counting of the upstream components of electricity production (i.e. to avoid double counting the biomass harvesting value addition). The 2013 SAM remains relevant, as these models are only updated to adjust for major changes within an economy.

<u>Livestock</u>

Upstream

The livestock (commercial animal product) industry has an extensive upstream value chain, with output from the sector requiring inputs from almost every other sector and/or industry in the economy. From a commodity consumption perspective, the largest first round industry inputs are from the fabricated metals, machinery and equipment sector (21.8%) and the petroleum products sector (18.1%). From the services and production side, the industry consumes primarily from the wholesale and retail trade industry, as well as from the finance and insurance (13.1%) and transport (7.1%) industries.

Downstream

Similarly, there is a well-developed downstream value chain for livestock in Namibia. The largest downstream consumer of commercial animal agriculture is the meat processing industry, which captures approximately 48% of the output value of the livestock industry, followed by leather production which captures approximately 20%. The wood and furniture industry captures approximately 12.5%, with hotels and tourism at 4.8% and 3.5%, respectively.

As a result, the industry multiplier effect is approximately 3.63x, implying that for every NAD1 of output generated by the industry, NAD3.63 of output is generated in the economy as a whole through up and downstream activities.

Construction

Upstream

The construction industry also has substantial multiplier effects through the economy. The first-round upstream multiplier of the sector is approximately 2.09x, driven primarily by input consumption from the wholesale and retail trade space (25.5%), the real estate and business services sector (16.8%) and the transport industry (9.5%).

Downstream

From a downstream perspective, the construction industry has a notably lower first-round multiplier effect, totalling just 1.13x. The small multiplier is created through various inter-sectoral linkages; however, none are individually larger than 2.0%.

In total, the construction industry has a 2.36x multiplier effect on the economy, implying that for every NAD1 dollar spent in this industry, a total of NAD2.36 of output is created in the economy.

Electricity

Upstream

The upstream value chain of the electricity sector is substantial, with a first-round multiplier effect of 1.59x. The main contributors to this are the consumption of petroleum products (23.2%) and fabricated metals, machinery and equipment (20.2%).[5]

Downstream

While there are sizable downstream multiplier effects from the electricity sector, it would be inaccurate to apply these multiplier effects to the output calculation, as no additional electricity will be available in the country as a result of this power station. Rather, locally produced electricity will replace imported electricity, but the downstream impact of the change will be negligible.

Because of the exclusion of downstream multipliers, for the purpose of this study, the multiplier effect derived from the introduction of the power station is exclusively upstream, at 1.59x.

[5] This is according to on an updated version of the 2014 Social Accounting Matrix, the most recent available and based on the structure of the economy at the time. The multiplier effect for electricity, particularly the consumption of petroleum products, is linked to the utilization of petroleum products in Namibia's energy generation at the time of the SAM compilation – including power stations such as the ANIXAS Power Station. Thus, while not entirely accurate for the specific biomass project, it provides a general indication. Adjustments to this for the purpose of this project would be speculative, and so it was decided to utilize the SAM in its current form.

Biomass

The biomass industry does not have a specific line in the Social Accounting Matrix, and it is thus assumed that the industry will have similar multiplier characteristics to those of the commercial cereal crop sector.

The commercial cereal crops sector has a 1.71x multiplier effect on the economy. This implies that NAD1 of output from the sector adds NAD1.71 to the local economy.

Overall, Indirect and Multiplier Contribution to GDP

The overall contribution to GDP contribution of the power station varies from year to year, as well as on the harvesting mechanism used and the price paid by NamPower to the biomass harvesting industry.

NAD Million	**Multiplier**	Year		
		-2	-1	0
Construction Value Addition, Gross		239.16	318.88	239.16
- Downstream	0.21	50.48	67.30	50.48
- Upstream	2.15	513.67	684.89	513.67
Total (Multiplied Value Addition)	2.36	564.14	752.19	564.14
Construction Value Addition to GDP		**0.13%**	**0.17%**	**0.12%**
Multiplied Value Addition to GDP		**0.31%**	**0.40%**	**0.29%**
Value addition/kWh		1.88	2.51	1.88
Value addition/kWh (real)		1.59	2.00	1.42

Table 11: Overall, Indirect and Multiplier Contribution to GDP During Construction Phase of Power Station

During the construction phase of the project, the direct and indirect contribution to GDP increases from 0.31% in the first year to 0.40% of GDP in the second year and reduces to 0.29% of GDP in the third year. The value addition/kWh of the construction phase of the project is estimated based on the total number of kWh produced by the power station over its operational lifetime. As a result of the relatively large value of the power station construction, the NAD/kWh value addition for the project construction is NAD1.59 in year one and NAD2.00 in year two of construction, dropping to NAD1.42 in year three.

Following the construction phase of the project, the indirect and multiplier impact on GDP drops initially, as both gross value addition in the biomass and electricity sectors drops in the early years of operation. Further to this, the benefits from increased carrying capacity on bush thinned land and the harvesting of livestock therefrom takes some years to develop as the re-stocking of this land is expected to be a gradual process over four years. Thereafter, the cumulative increases in harvested land, resultant rangeland restoration and increases in carrying capacity, and increased livestock production, see the total value addition increasing over the full 25-year lifespan of the project (after which it would be assumed to flatten out for as long as the land is kept clear of excess bush). The contribution to GDP sees a similar trend, however the assumption that encroachment resumes once again 20 years after land was first harvested results in GDP growth expanding faster than the marginal value addition, ultimately resulting in a slow reduction in the ratio of value addition to GDP.

As illustrated in the following charts, the greatest gross value addition from a price-point perspective can be seen at the highest price point sampled – NAD900/t. The reason for this is that the multiplier effects from biomass value addition are greater than those from the additional electricity value addition, as the latter is simply a substitution for the already available, but imported, electricity.

Direct, Indirect and Induced Employment

Direct

The direct employment generated by the power station is covered in the microeconomic section of this report.

Indirect

The indirect employment created through harvesting activities are covered in the microeconomic section of this report.

Induced

In order to estimate induced employment as a result of upstream and downstream activities, an output-weighted ratio of employees per million Namibia Dollars' worth of value addition was estimated using the 2018 National Accounts and 2016 Namibia Labour Force Survey (NLFS). The output-weighted ratio was then multiplied with the gross value addition (discounted to 2018 levels) for the various sectors that was derived from the social accounting matrix.

	NLFS 2016	Value Addition 2018 (NAD Million)	Employees/ Million NAD Value Addition
Agriculture, forestry and fishing	167,242	14,225	11.76
Accommodation and food service activities	83,056	3,480	23.86
Construction	45,057	3,828	11.77
Real estate and other service activities	145,822	19,359	7.53
Human health and social work activities	19,527	6,160	3.17
Wholesale and retail trade	80,852	17,918	4.51
Transport and storage	24,710	5,374	4.60
Education	46,923	17,441	2.69
Manufacturing	45,057	22,374	2.01
Electricity and Water and related industries	7,373	6,667	1.11
Financial and insurance activities	13,861	13,845	1.00
Public administration and Defence; compulsory social security	34,174	20,777	1.64
Mining and quarrying	12,087	16,008	0.76

Table 12: Direct, Indirect and Induced Employment

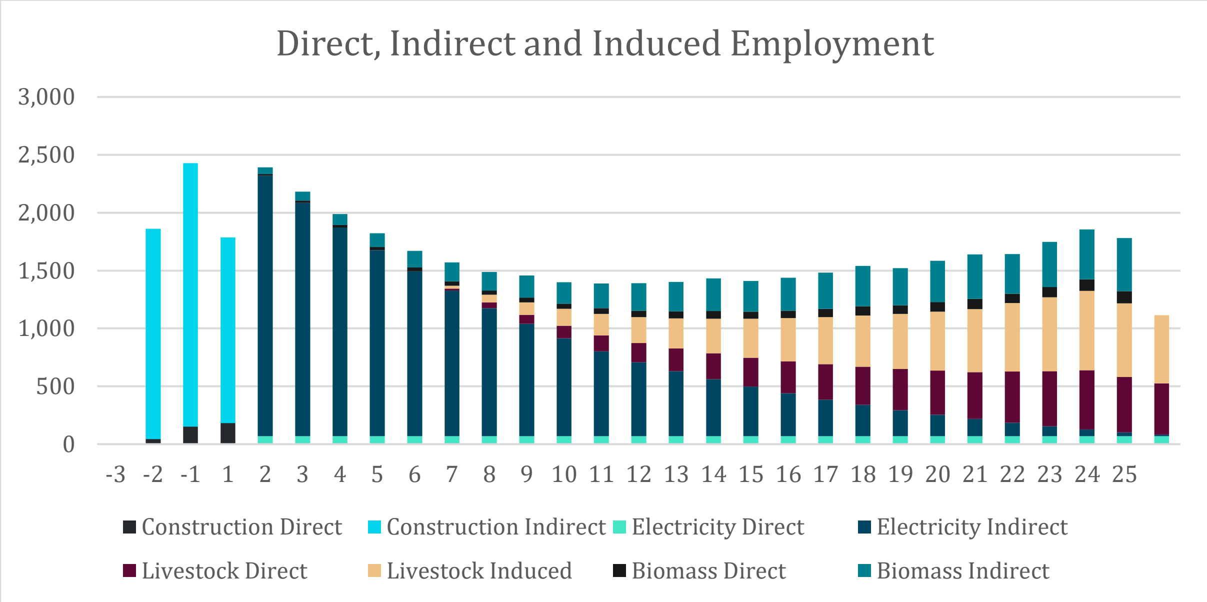

Figure 20: Direct, Indirect and Induced Employment (Biomass @ NAD750/t)

In total, the livestock sector creates a large number of direct and induced employment opportunities over the lifespan of the power station, which jobs may well be sustained thereafter should the increased carrying capacity of the land be maintained through aftercare activities.

Similarly, harvesting activities create a number of induced job opportunities, however the magnitude thereof depends heavily on the price/tonne paid by NamPower to harvesting entities.

Contribution to Corporate and Personal Income Tax in Nominal and Real Terms are Presented Below

In the case of the power station, the higher the price paid for fuel, the lower the corporate income tax paid by the power station. At the highest price point, the power station runs into losses from Year 5, after which it does not contribute to income tax at all.

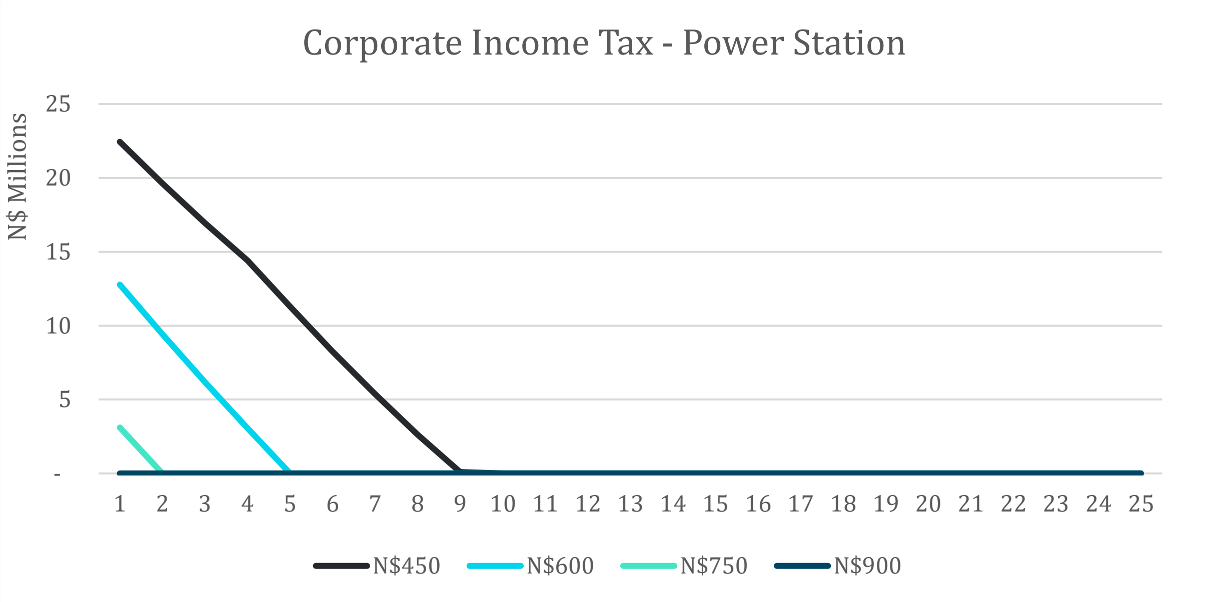

Figure 21: Corporate Income Tax - Power Station - Nominal

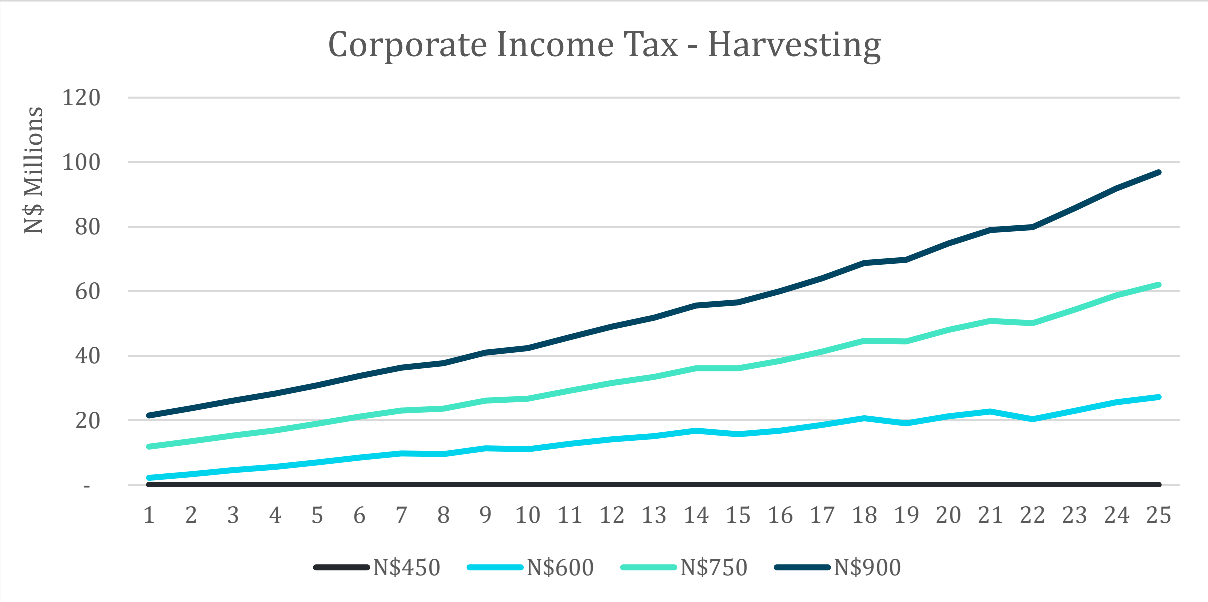

Figure 22: Corporate Income Tax - Harvesting – Nominal

	NPV of Taxes	NPV/kWh
Power station		
NAD450/t	85,039,433	0.35
NAD600/t	28,298,458	0.12
NAD750/t	2,946,372	0.01
NAD900/t	0	0
Harvesters		
NAD450/t	5,301,391	0.02
NAD600/t	173,499,642	0.71
NAD750/t	411,691,764	1.68
NAD900/t	649,883,886	2.65

Table 13: Net Present Value of Corporate Income Taxes

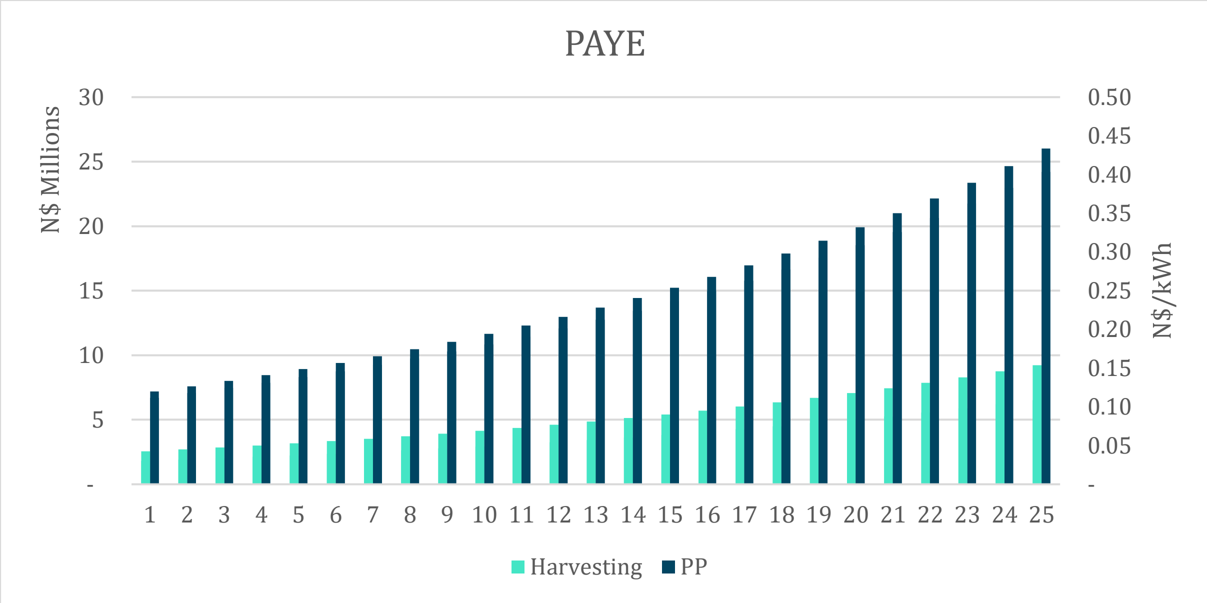

Figure 23: PAYE Contributions - Nominal

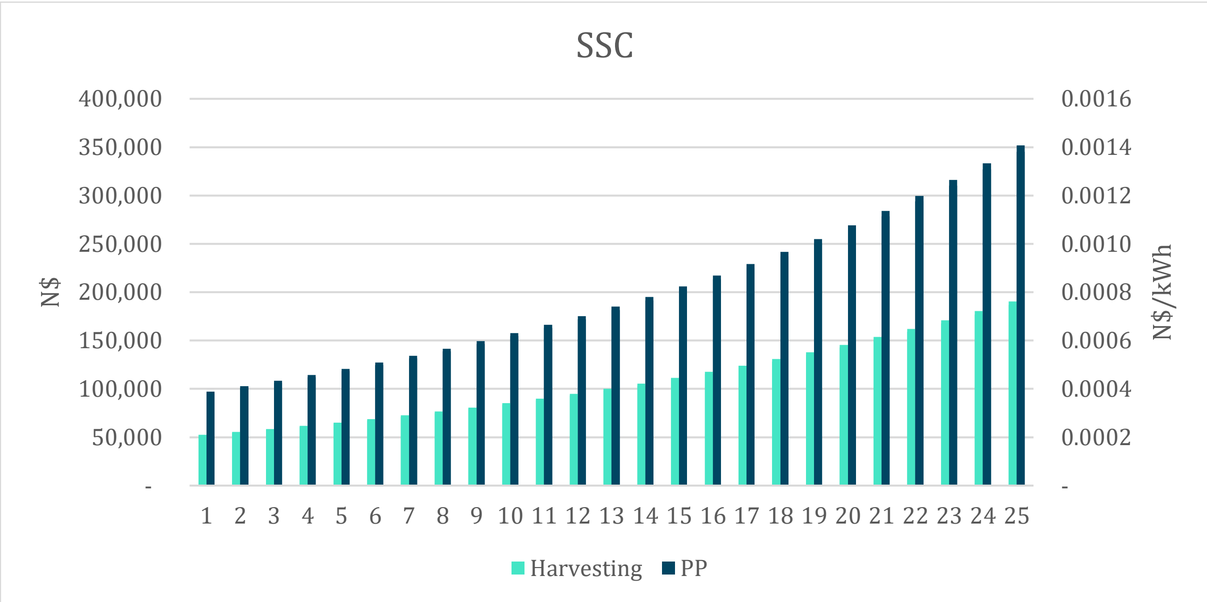

Figure 24: SSC Contributions - Nominal

Contributions to social security will be minimal given that there are statutory limits to SSC contributions.

Inflation/ Deflation

Based on 2019 annual energy sales by NamPower of 4,159GWh (NamPower financial year), this power station will represent approximately 7.2% of total energy sales. According to discussions with NamPower, with the current execution philosophy the erection of this power station will have little to no impact on the overall tariff charged to consumers.

Furthermore, electricity, gas and other fuels make up 3.86% of the inflation basket and is generally not a significant direct input into manufacturing for locally consumed products. As a result, we expect the inflationary impact to be negligible.

Balance of Payments

The effect of the power station and harvesting on the balance of payments are the net effect of:

- Inflows of financial capital
- Outflows of repayment on debt and interest
- Outflows from capital expenditure for the power station
- Import substitution effect of electricity
- Outflows from capital expenditure for harvesting equipment, tools and spare parts, and subsequent replacements
- Increased diesel imports for harvesting equipment
- Increased exports of live cattle

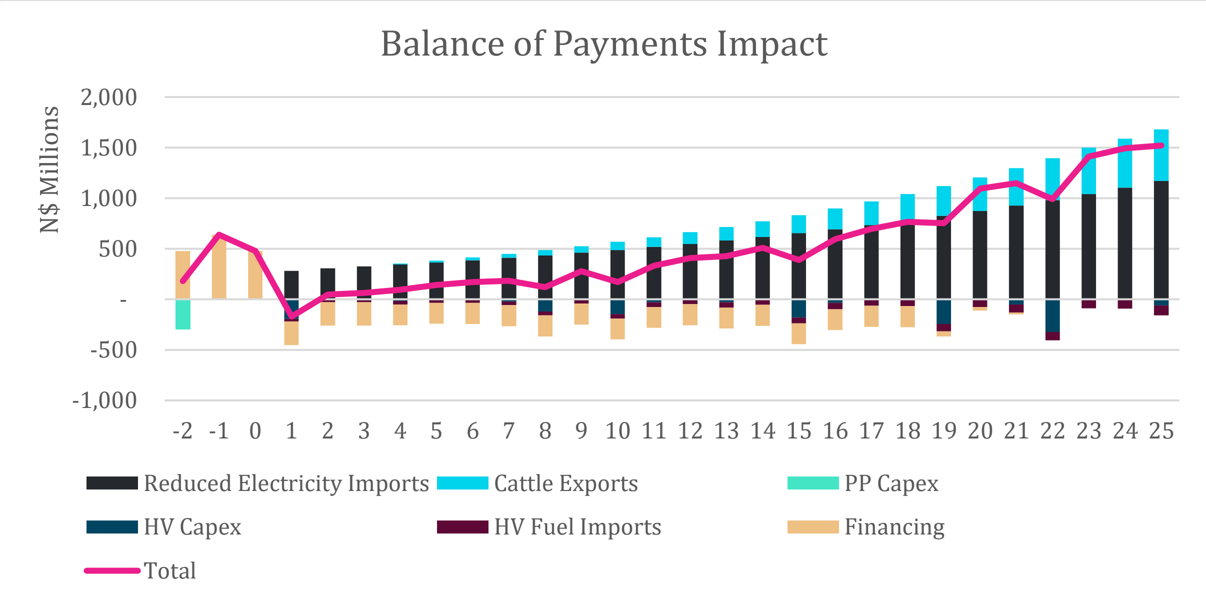

Figure 25: Balance of Payments Effects

The initial impact of the construction of the power station would be a relatively large outflow to import the equipment for the 40MW power station. However, this would be offset by financing obtained from foreign sources, such as the Development Financing Institutions (e.g. AfD, EIB, KfW etc.). These inflows will be followed by the outflows in the form of payments of interest and principal.

The largest contributor to the positive balance of payments effect is the import substitution effect of electricity. Namibia's two main import partners are ESKOM and ZESA. The reduction in imported electricity is a net benefit of NAD15.5 billion over the power station's 25 years, particularly as it pertains to imports from Zesco (Zambia) and ZESA (Zimbabwe) which are denominated US Dollars and carry a forex risk.

Harvesting, especially fully mechanised harvesting, is extremely capital intensive. Additionally, the machinery, specifically the chippers, also require a large amount of (imported) diesel to operate. We estimate the imported fuel to cost NAD1.4 billion over the project period.

Cattle exports also make a moderate contribution to net-export gains for Namibia, with exports starting from year four. In nominal terms, total cattle exports due to rangeland restoration and the increased carrying capacity of land as a result of bush-thinning will total NAD4.5 billion over the project lifetime. These sales are a key part of the revenue generated by farmers from cattle sales but are not net-of-operational-costs, meaning they are not comparable to gross value addition. Nevertheless, they contribute to the country's hard currency earnings more than to national GDP.

	NPV of BOP (2020 NAD values)	**NPV/kWh**
BOP Real	6,140,376,161	1.001

Table 14: Net Present Value of the Balance of Payments Impact

Security of Electricity Supply

The security of supply benefits of the project are twofold. Firstly, the power station falls in a portfolio of renewable energy sources set by the 2016 National Integrated Resource Plan (NIRP). Furthermore, given that wind and solar sources are often intermittent in nature, this particular power station represents an important source of dispatchable baseload supply. Having a baseload producer on notice adds desperately needed flexibility to the current renewable offerings.

Additionally, given the fact that the fuel supply is in abundance in the surrounding area also means that the fuel supply is secure. It is imperative that the inventory of fuel is sufficient to minimise the possibility of downtime due to insufficient fuel stock. This will likely require the power station to store 20,000 tonnes (or two months) of fuel at the minimum.

However, as the power station is relatively small, it is assumed that the contribution to the security of supply is limited.

Conclusion

The underlying assumptions of this report are based on figures and information provided by NamPower, N-BiG, as well as the referenced material. According to these, an annual feedstock requirement of 201,369.67t of biomass is required for the power station. At an average yield of 12.65t/ha, we calculate the mechanized harvesters will bush thin approximately 15,919 hectares of land a year. As per the terms of reference, four different power stations are considered for purposes of comparative analysis (although the bulk of this report focuses on the base 40MWe power station), updating a previous study assessing just one 20MWe power station. The format of this report, as well as the various scenarios and core variables were selected in consultation with NamPower.

Despite the existence of other users of encroacher bush within the proposed harvesting area, there does not exist sufficient competition for the resource to the extent that available supply for the proposed power station may be threatened. In this regard the available supply is far greater than total demand across all users, across all modelled power stations.

The overall microeconomic effect is the result of employment creation, salaries and wages, agricultural benefits from rangeland restoration and increased livestock production, improved groundwater recharge, reduced CO2 emissions and the value addition derived from biomass harvesting. At a price of NAD750/t, the 40MWe power station scenario, at a capacity factor of 70%, generates an aggregate gross value addition benefit of NAD0.81/kWh (discounted at 5.5% per annum).

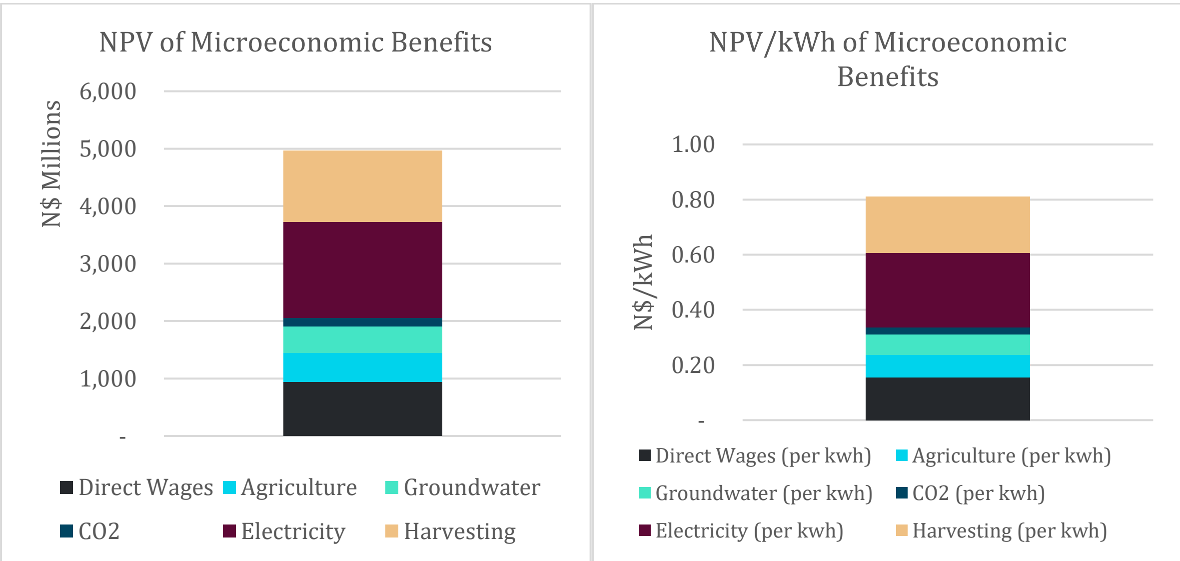

Figure 26: NPV of Microeconomic Benefits

On the macroeconomic impact, it was noted that while the majority of the employment is generated at the micro level, the contribution to GDP by both personal and corporate income tax is heavily dependent on the biomass fuel resource price. The large import factor of the power station construction sees an initial negative impact on GDP. However, the operational phase of the power station has a smaller, but longer-lived contribution to GDP over its 25-year lifespan, of between -0.03% and 0.013%. The impact on inflation is expected to be negligible, as electricity (and other fuels) make up less than 4% of the inflation basket. The balance of payments sees net positive effects, largely due to the import-substitution of electricity and some contribution from increased cattle sales and beef exports.

The net present value of the macroeconomic benefits total NAD16.4 billion (discounted at 5.5% p.a.), or NAD2.68/kWh.

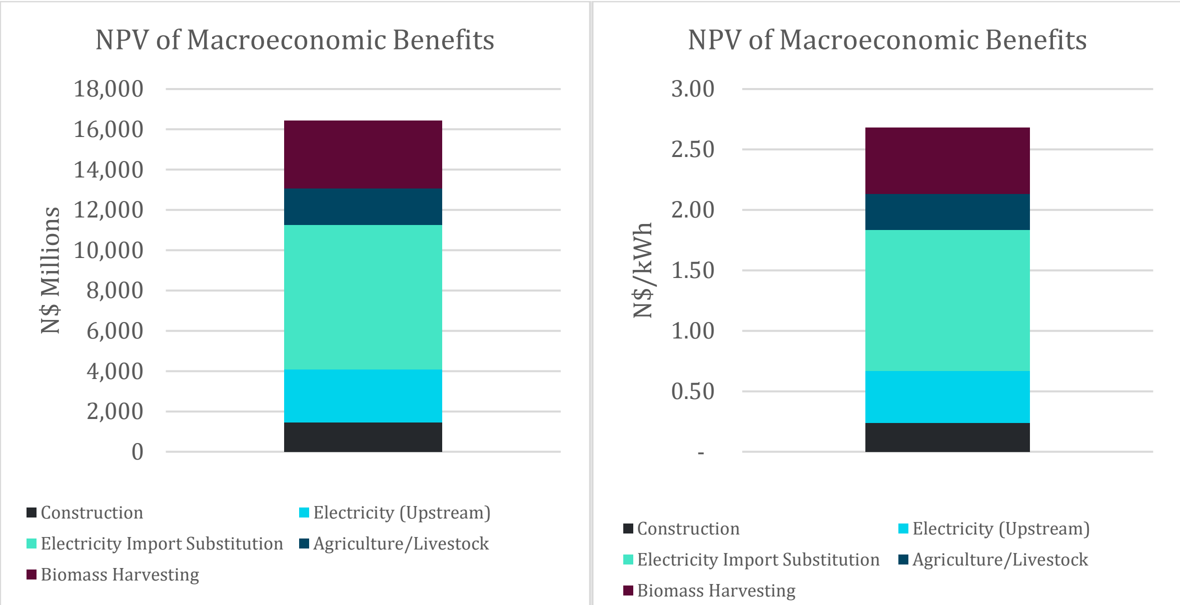

Figure 27: NPV of Macroeconomic Benefits (NAD/kWh)

The key considerations for this project are around the price paid for biomass fuel resource and the station's capacity factor. A higher price is beneficial to harvesters, but produces a lower return for the biomass power station. So, while a price of NAD900/t is preferable for the harvesters, this jeopardises the feasibility of the power station. On the other hand, the NAD600/t price for the biomass fuel resource, while preferable for the power station, generates the lowest profits for the harvesters. The initial biomass fuel resource price of NAD450/t (from the original study) is most beneficial for the power station, but is insufficient for harvesters to generate a profit and is therefore not recommended. The NAD750/t price point, as the midpoint of profitable prices (for the harvesters) is the most feasible of the assessed price points for both the power station and harvesters, and so, many calculations adopt this price point.

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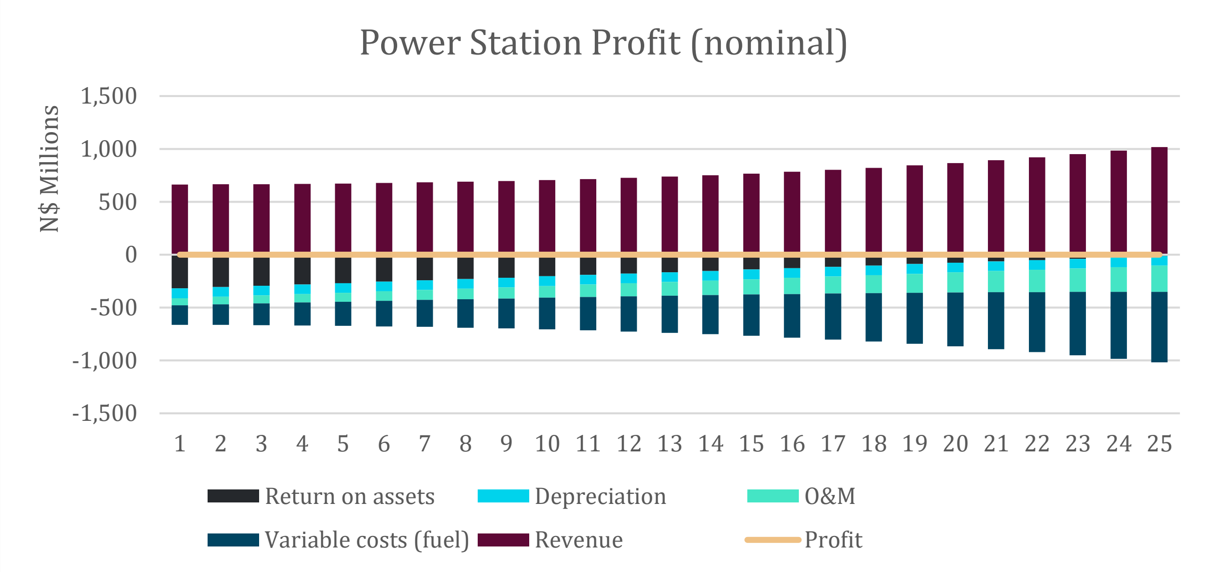
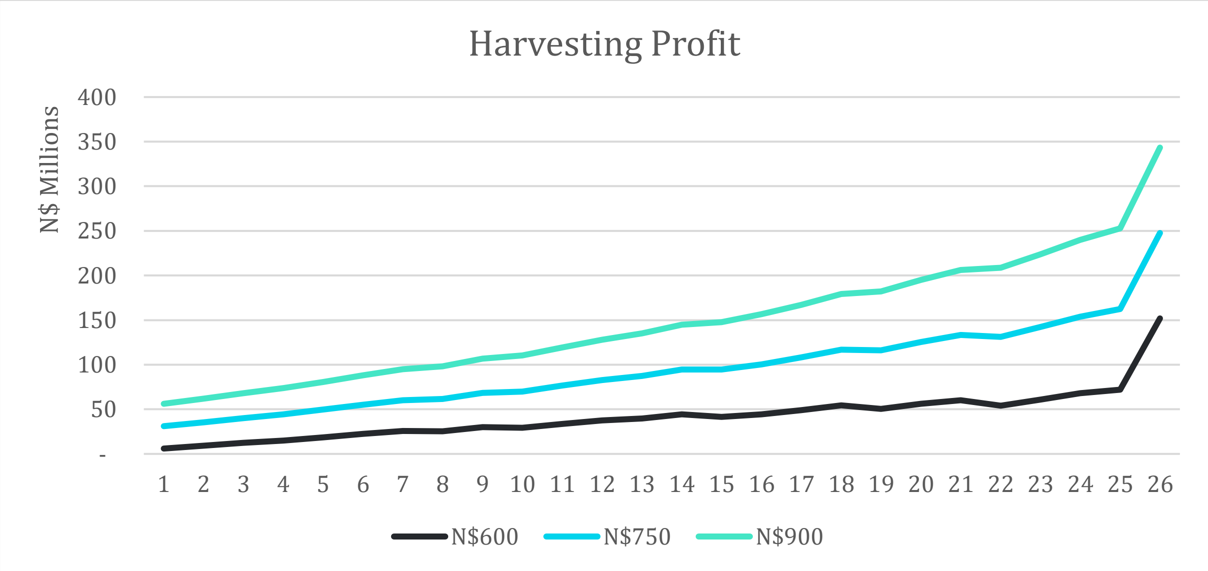
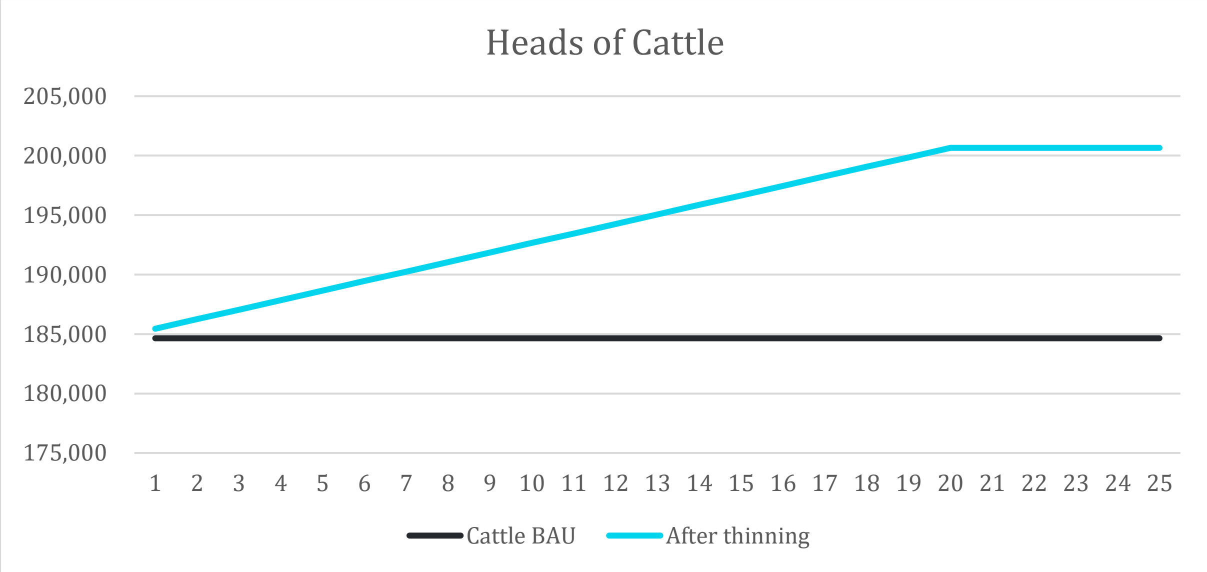
Appendix 1

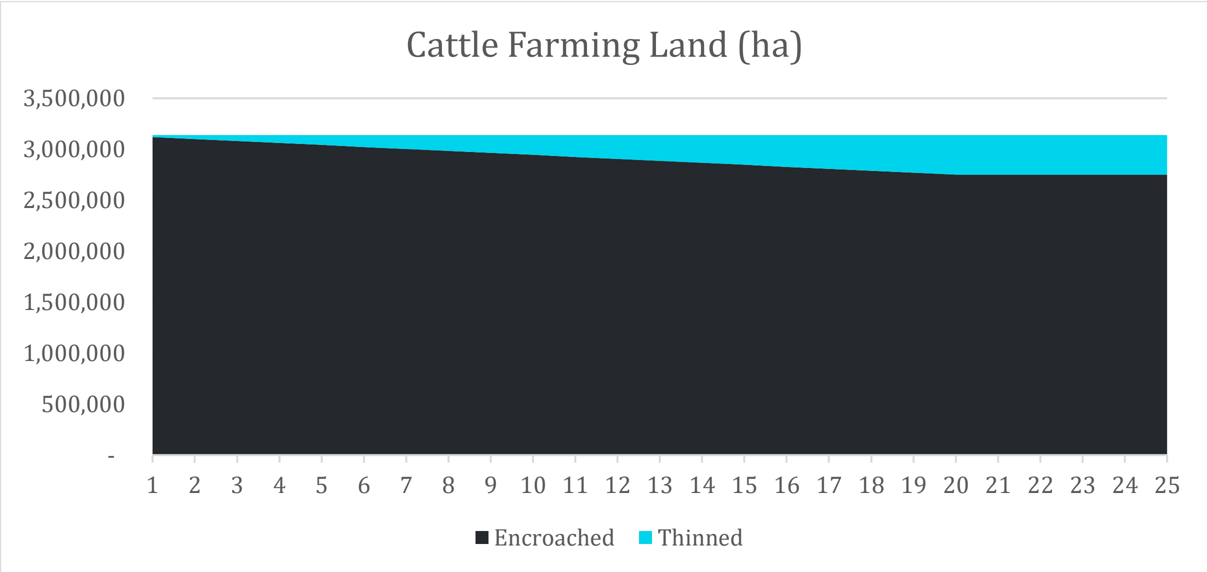
Scenario:

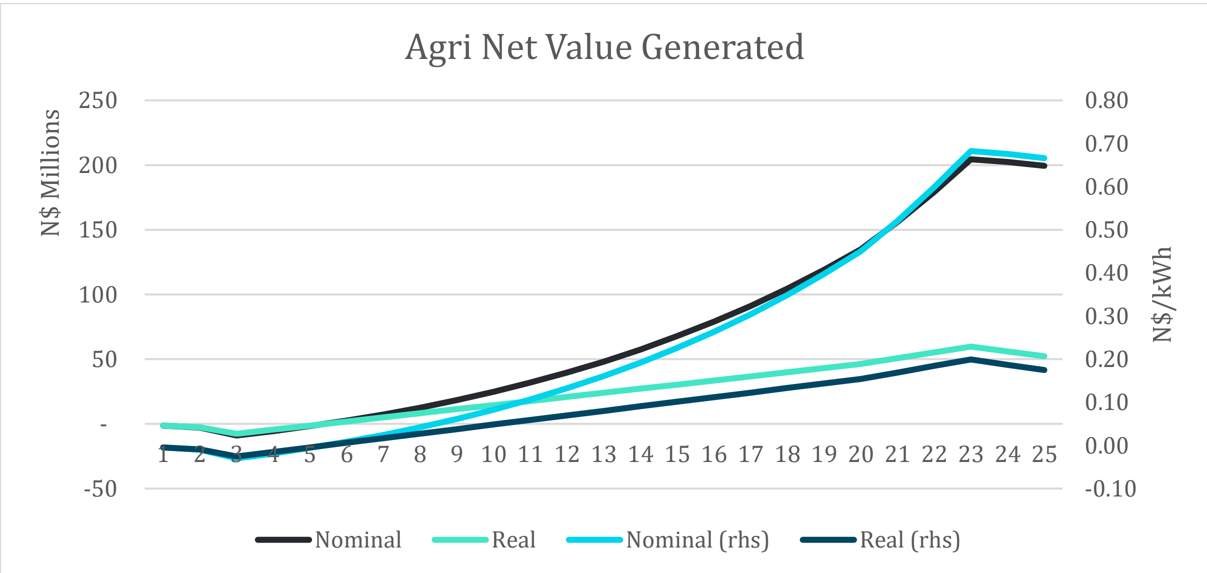
- Power station = 40MWe
- Capacity Factor = 85%
- Price per kWh installed = USD 3500/kW






Heads of Cattle
205,000
200,000
195,000
190,000
185,000
180,000
175,000
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
Cattle BAU
After thinning


Cattle Farming Land (ha)
3,500,000
3,000,000
2,500,000
2,000,000
1,500,000
1,000,000
500,000
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
Encroached
Thinned

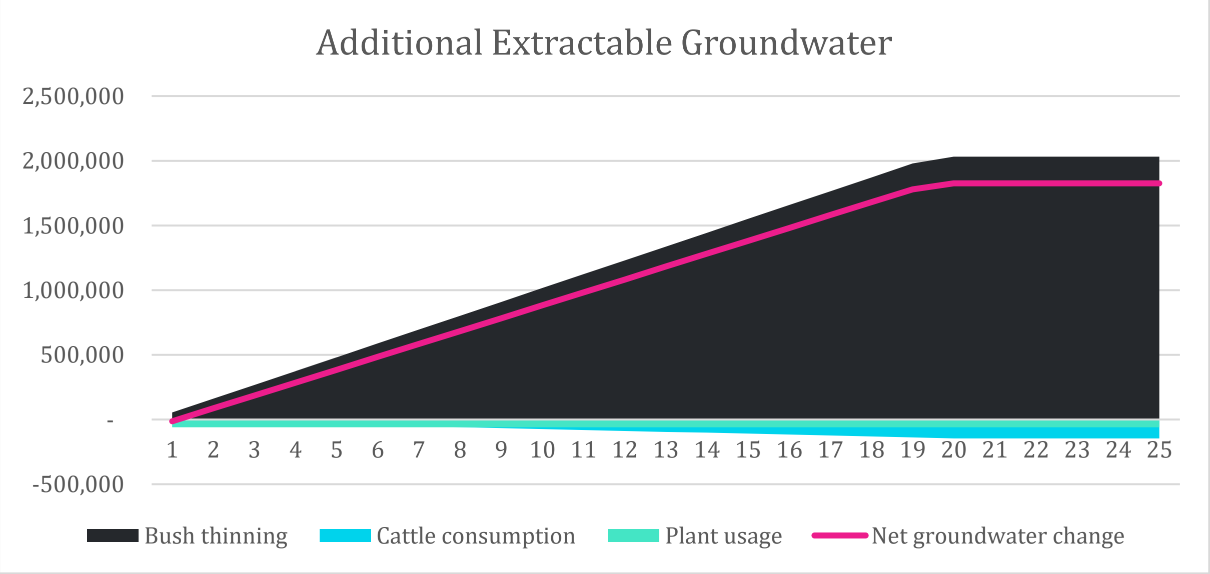

Agri Net Value Generated
N$ Millions
250
200
150
100
50
-
-50
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
-0.10
N$/kWh
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
Nominal
Real
Nominal (rhs)
Real (rhs)

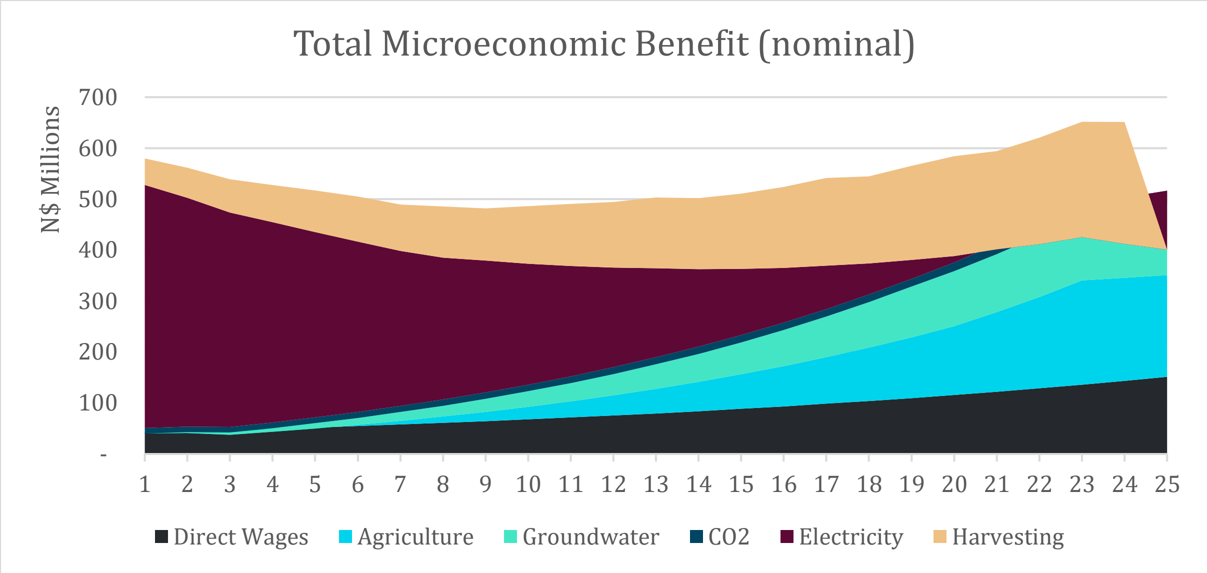
Activity	$kgCO_2e$ over 25 Years (per power station)	$kgCO_2e$ / kWh
Harvesting	166,125,646	0.02
Transport	28,928,410	0.00
Conversion	112,320,004	0.02
Soil Carbon	284,757,525	0.04
Livestock	879,169,611	0.12
Total	**1,471,301,197**	**0.20**

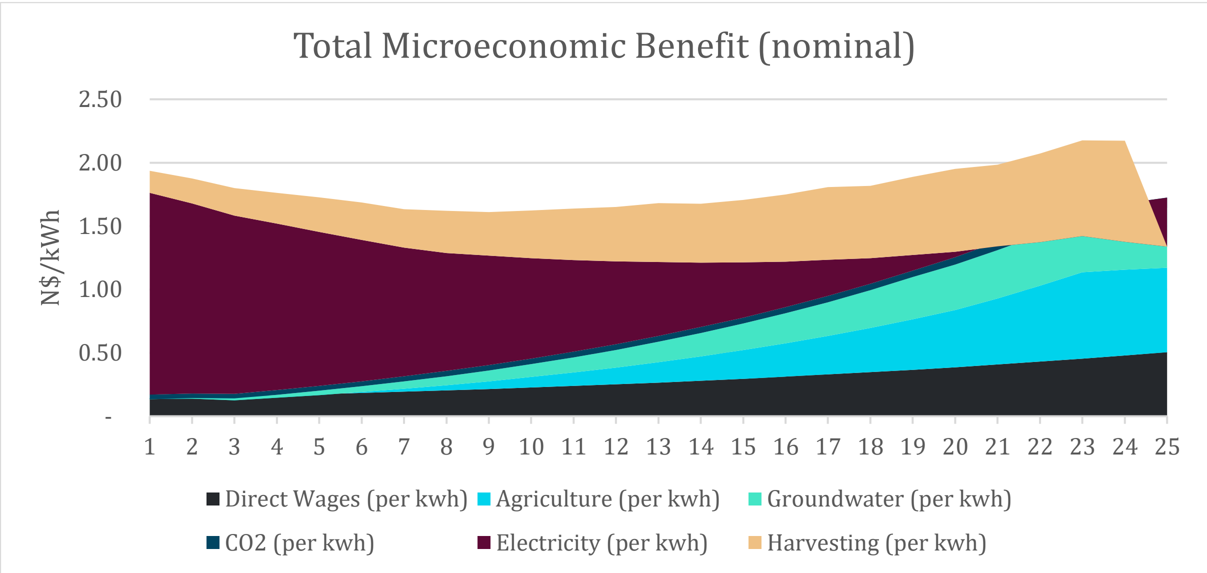
	$kgCO_2e$ over 25 Years			
Grid Emission Factor	**Emitted**	**Displaced**	**Project Net**	**$KgCO_2$ per kWh**
Namibian Grid = 0.4898 (WSP)	1,471,301,197	-3,667,622,543	-2,196,321,346	-0.29
SAPP = 0.9644 (UNFCCC)		-7,221,427,482	-5,750,126,285	-0.77

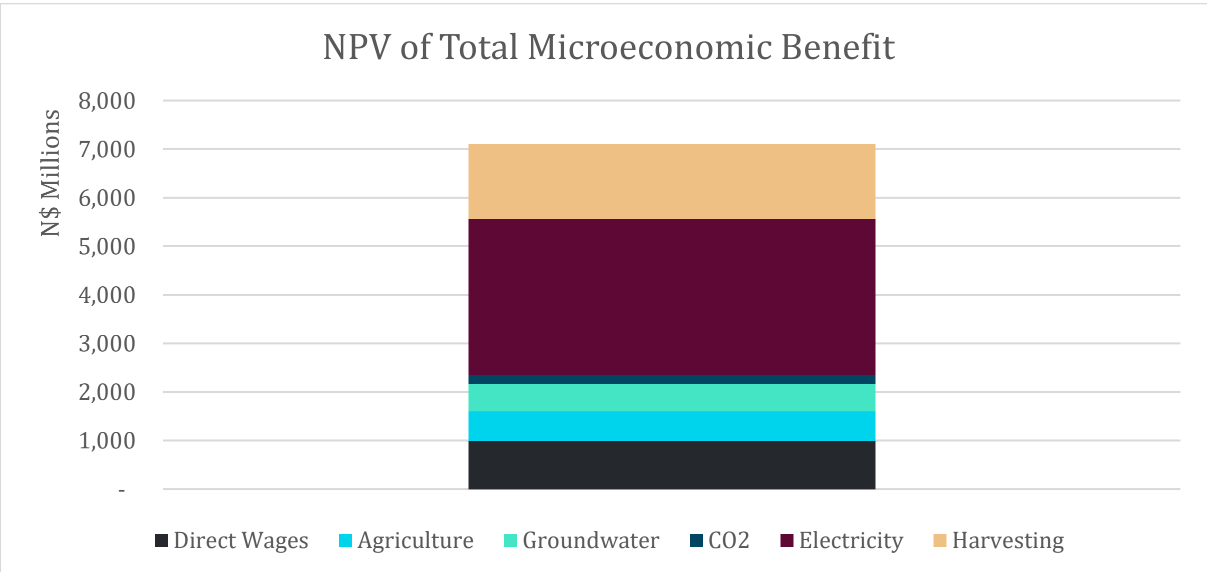
The overall value of net emissions, in constant prices, for the project lifespan amounts to:

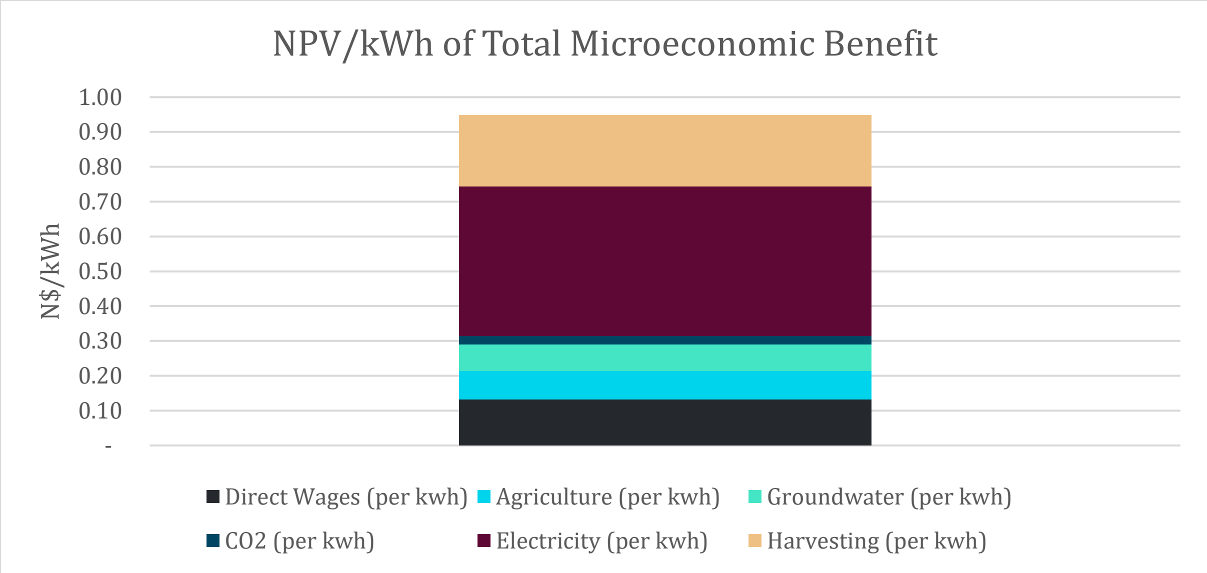
	Value of Net Emissions at beginning of operational period
Carbon Price	**NIRP NAD85**
NPV NAD	475,711,216
NAD/kWh	0.06

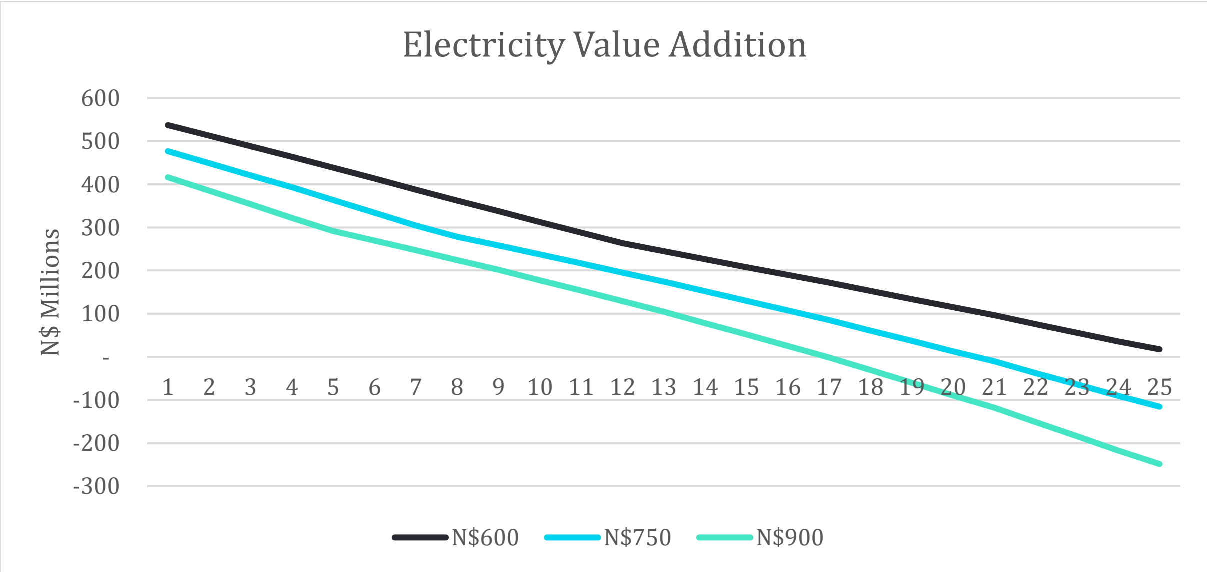


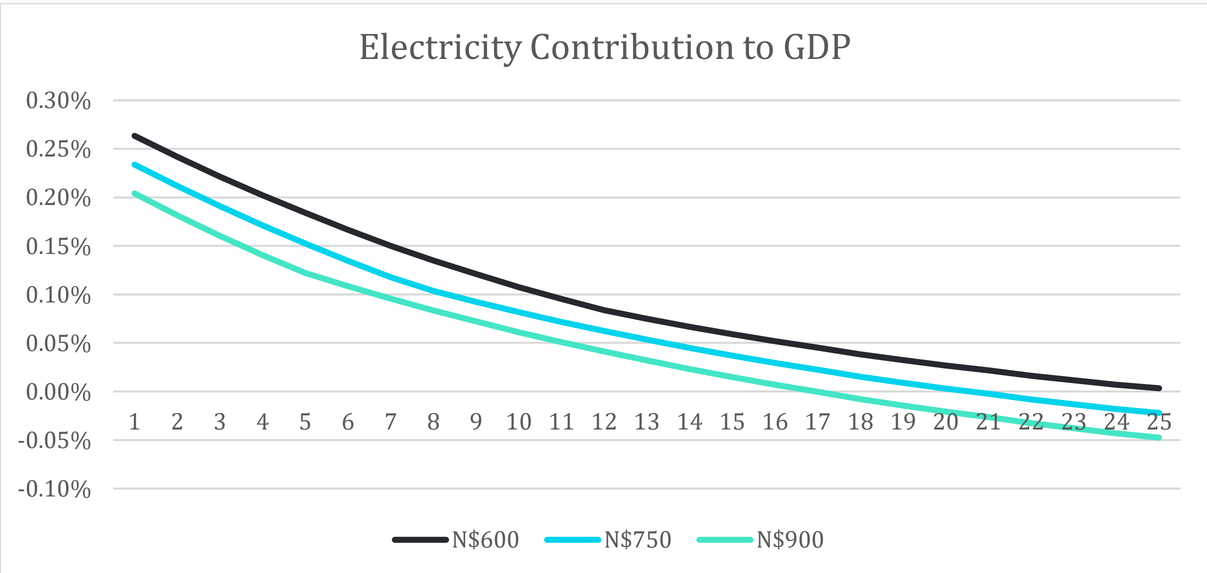

Total Microeconomic Benefit (nominal)
N$ Millions
700
600
500
400
300
200
100
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
Direct Wages
Agriculture
Groundwater
CO2
Electricity
Harvesting

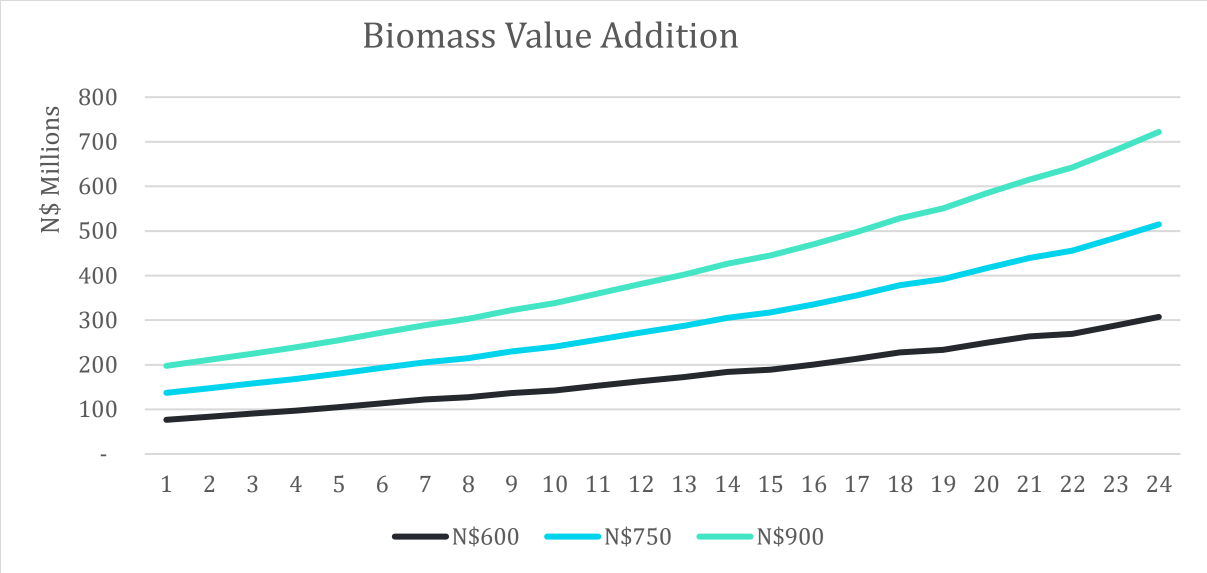

Total Microeconomic Benefit (nominal)
N$/kWh
2.50
2.00
1.50
1.00
0.50
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
Direct Wages (per kwh)
Agriculture (per kwh)
Groundwater (per kwh)
CO2 (per kwh)
Electricity (per kwh)
Harvesting (per kwh)

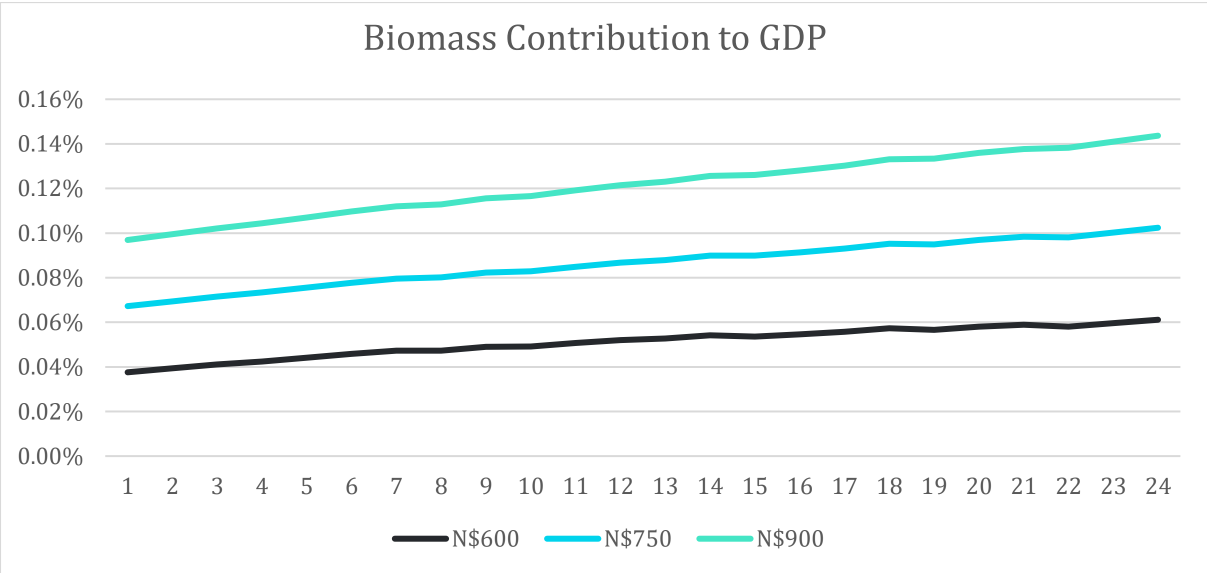

NPV of Total Microeconomic Benefit
N$ Millions
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
-
Direct Wages
Agriculture
Groundwater
CO2
Electricity
Harvesting

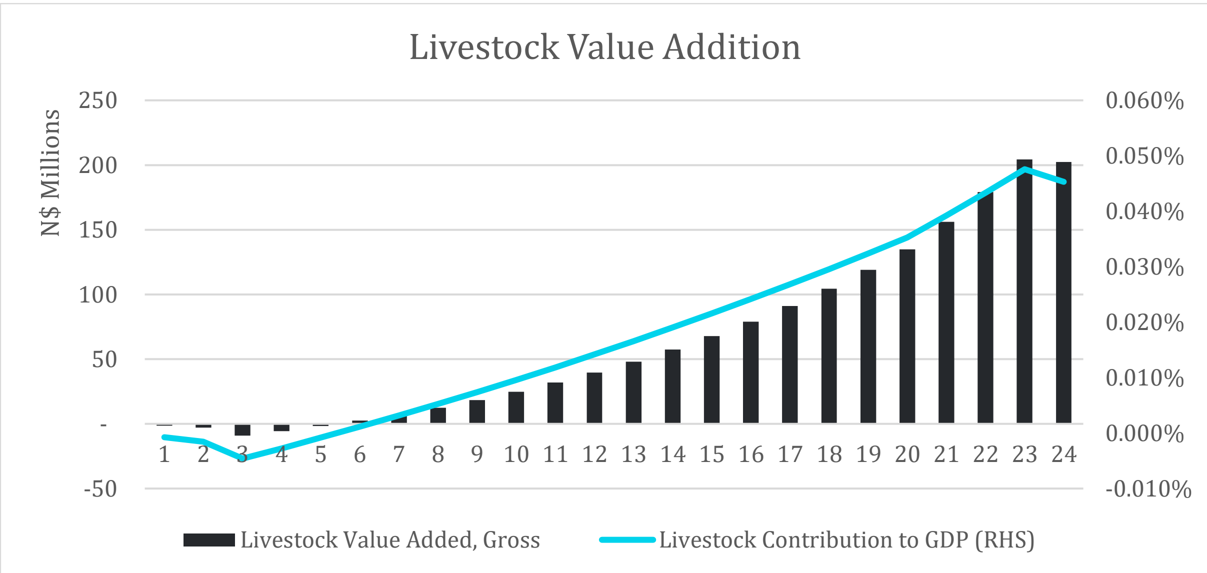

NPV/kWh of Total Microeconomic Benefit
N$/kWh
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
-
Direct Wages (per kwh)
Agriculture (per kwh)
Groundwater (per kwh)
CO2 (per kwh)
Electricity (per kwh)
Harvesting (per kwh)

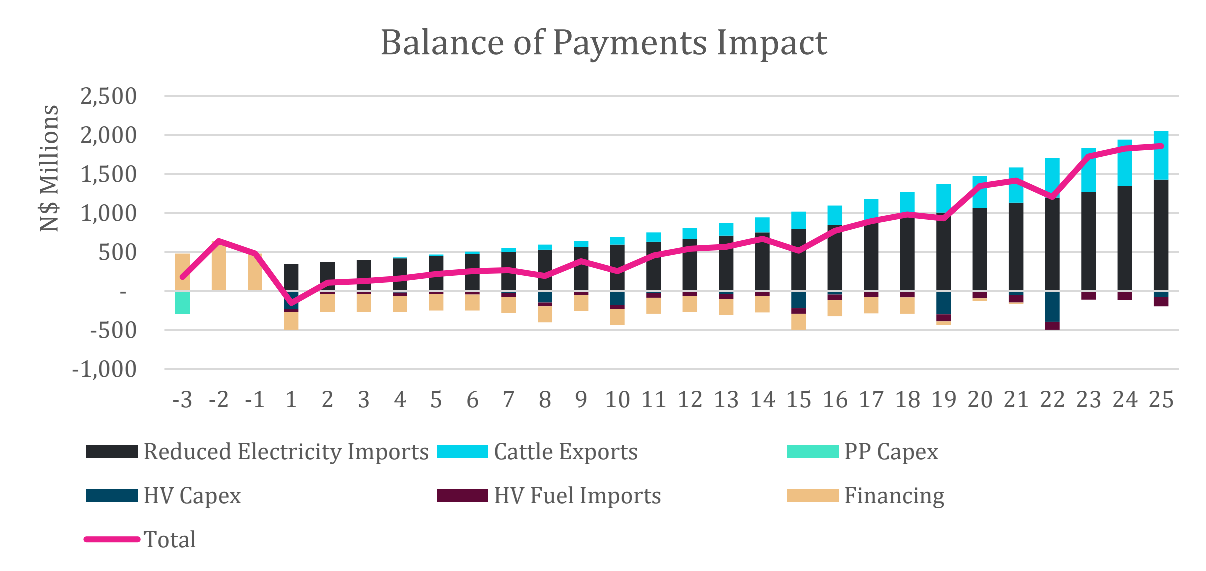

Electricity Value Addition
N$ Millions
600
500
400
300
200
100
-
-100
-200
-300
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
N$600
N$750
N$900

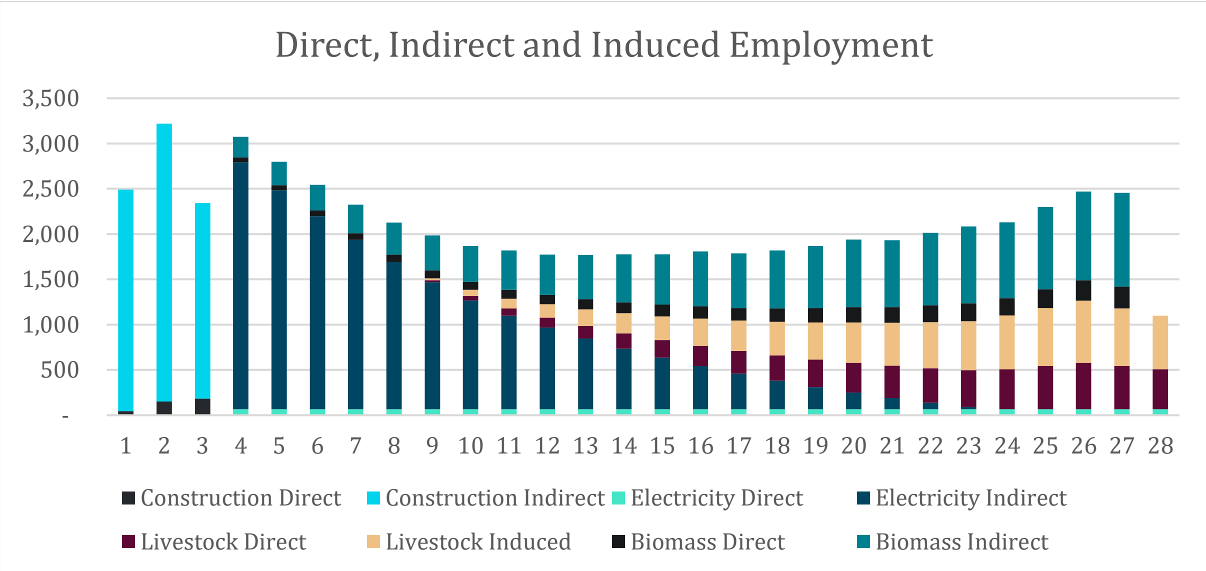

Electricity Contribution to GDP
0.30%
0.25%
0.20%
0.15%
0.10%
0.05%
0.00%
-0.05%
-0.10%
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
N$600
N$750
N$900

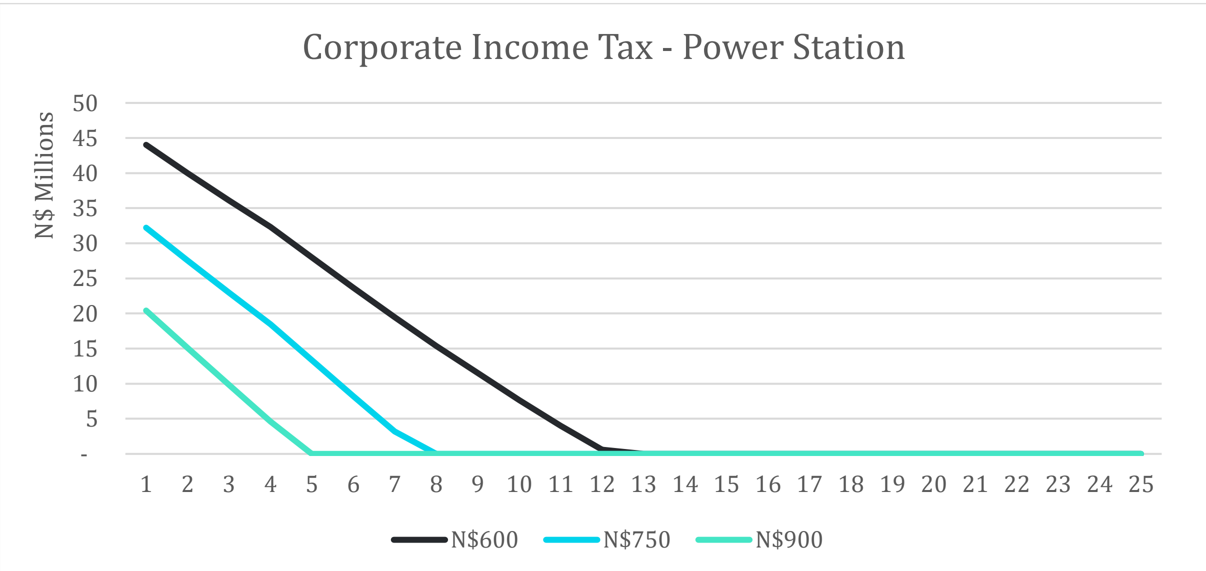

Biomass Value Addition
N$ Millions
800
700
600
500
400
300
200
100
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
N$600
N$750
N$900

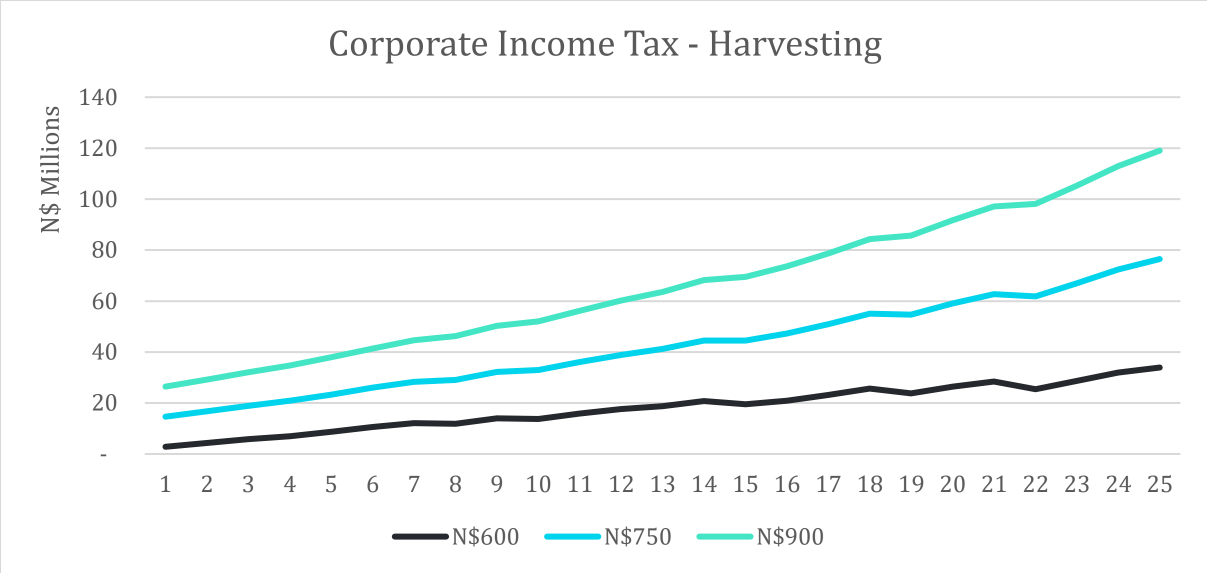

Biomass Contribution to GDP
0.16%
0.14%
0.12%
0.10%
0.08%
0.06%
0.04%
0.02%
0.00%
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
N$600
N$750
N$900


Livestock Value Addition
N$ Millions
250
200
150
100
50
-
-50
0.060%
0.050%
0.040%
0.030%
0.020%
0.010%
0.000%
-0.010%
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Livestock Value Added, Gross
Livestock Contribution to GDP (RHS)

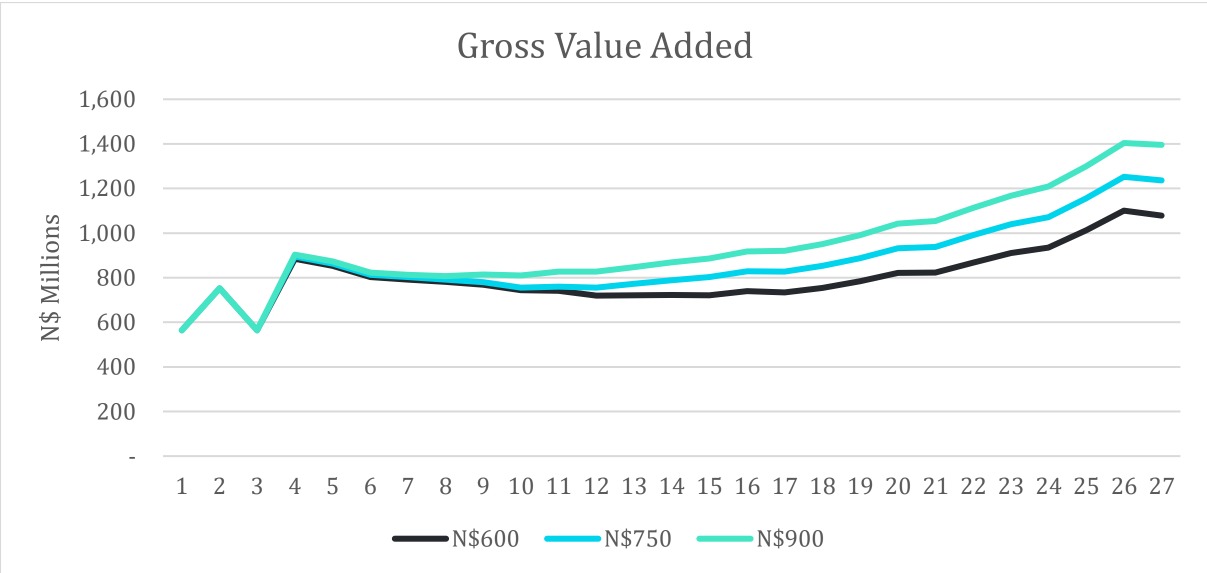

Balance of Payments Impact
N$ Millions
2,500
2,000
1,500
1,000
500
-
-500
-1,000
-3 -2 -1 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
Reduced Electricity Imports
Cattle Exports
PP Capex
HV Capex
HV Fuel Imports
Financing
Total


Direct, Indirect and Induced Employment
3,500
3,000
2,500
2,000
1,500
1,000
500
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28
Construction Direct
Construction Indirect
Electricity Direct
Electricity Indirect
Livestock Direct
Livestock Induced
Biomass Direct
Biomass Indirect

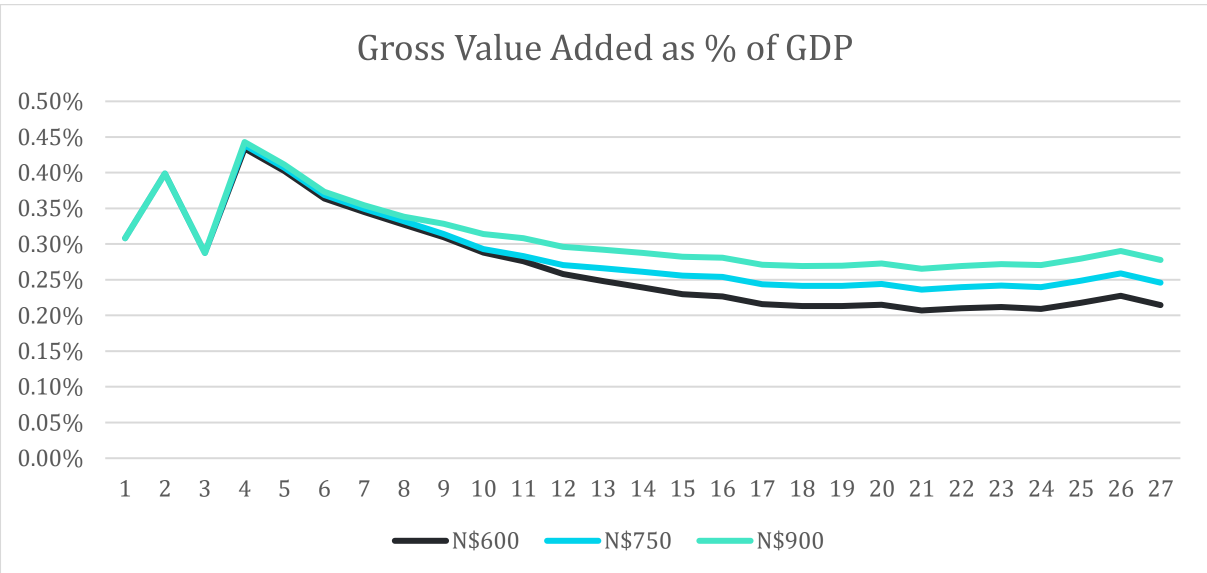

Corporate Income Tax - Power Station
N$ Millions
50
45
40
35
30
25
20
15
10
5
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
N$600
N$750
N$900



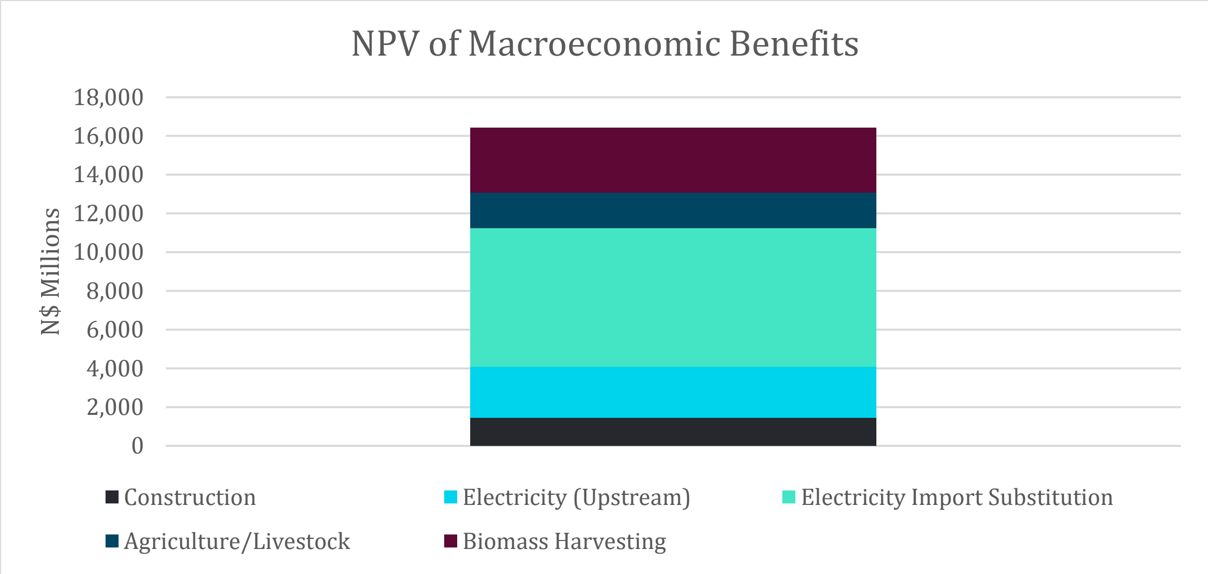
Corporate Income Tax - Harvesting
N$ Millions
140
120
100
80
60
40
20
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
N$600
N$750
N$900

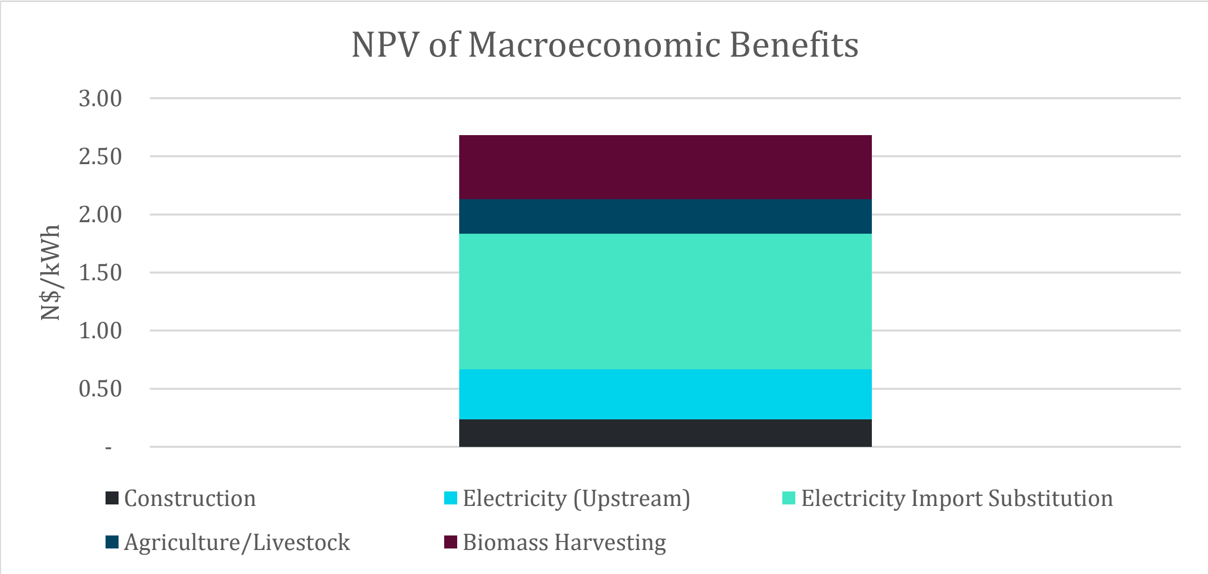


Gross Value Added
N$ Millions
1,600
1,400
1,200
1,000
800
600
400
200
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27
N$600
N$750
N$900



Gross Value Added as % of GDP
0.50%
0.45%
0.40%
0.35%
0.30%
0.25%
0.20%
0.15%
0.10%
0.05%
0.00%
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27
N$600
N$750
N$900

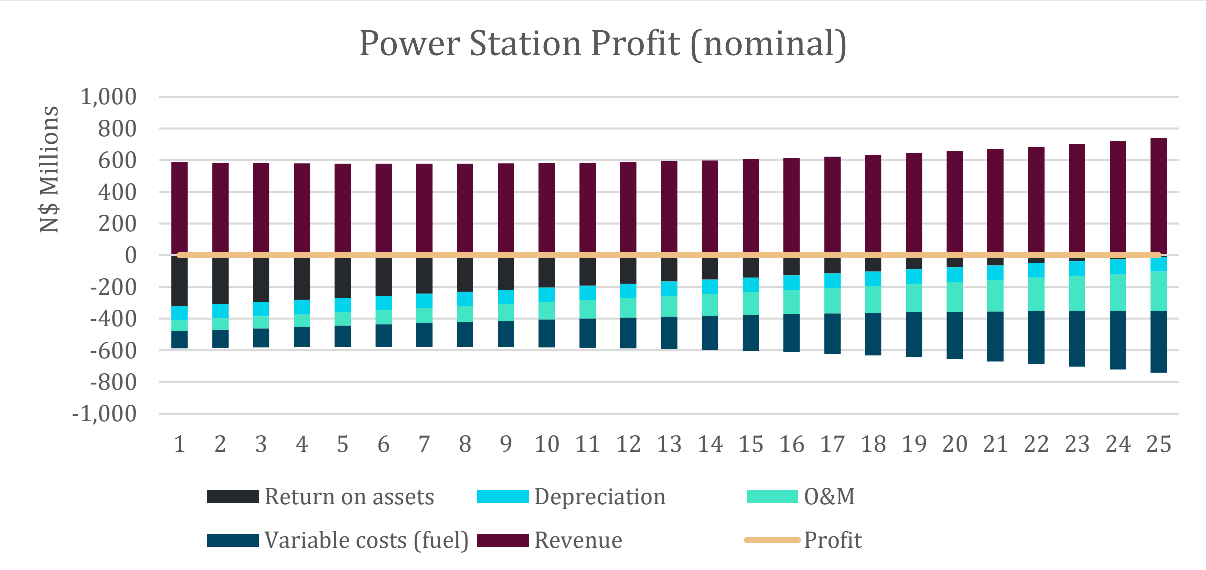

NPV of Macroeconomic Benefits
18,000
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
N$ Millions
Construction
Electricity (Upstream)
Electricity Import Substitution
Agriculture/Livestock
Biomass Harvesting

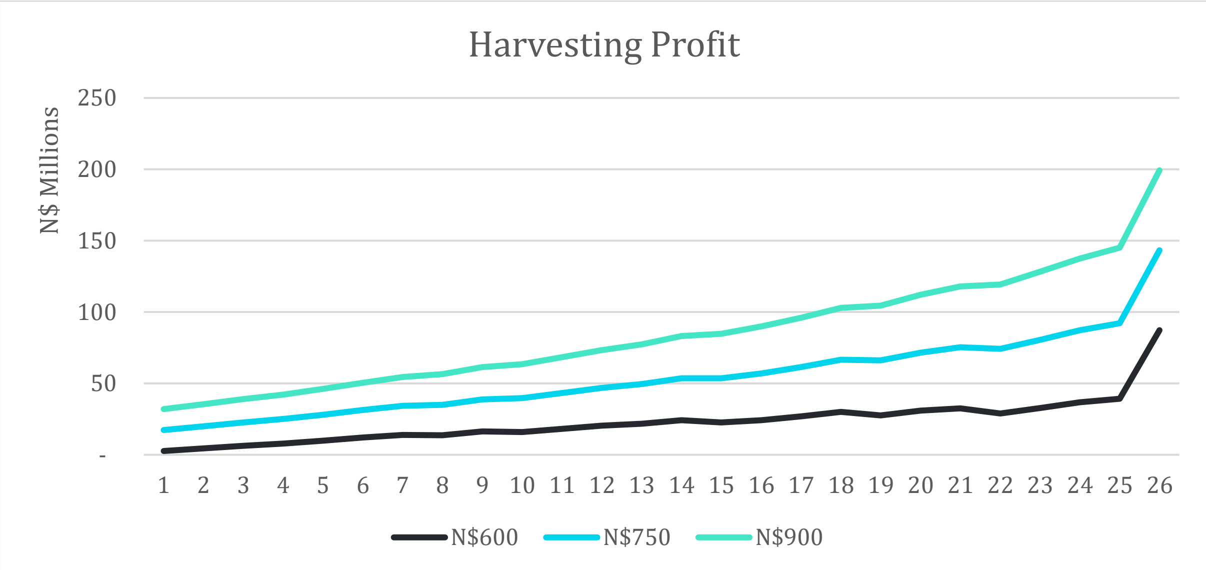

NPV of Macroeconomic Benefits
3.00
2.50
2.00
1.50
1.00
0.50
-
N$/kWh
Construction
Electricity (Upstream)
Electricity Import Substitution
Agriculture/Livestock
Biomass Harvesting

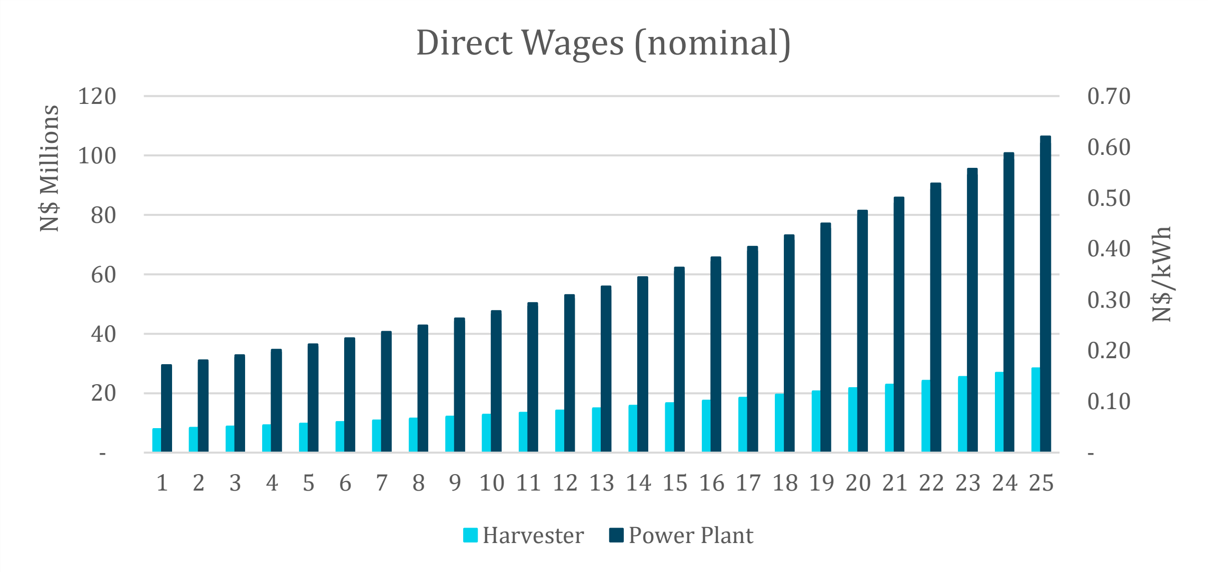
Appendix 2

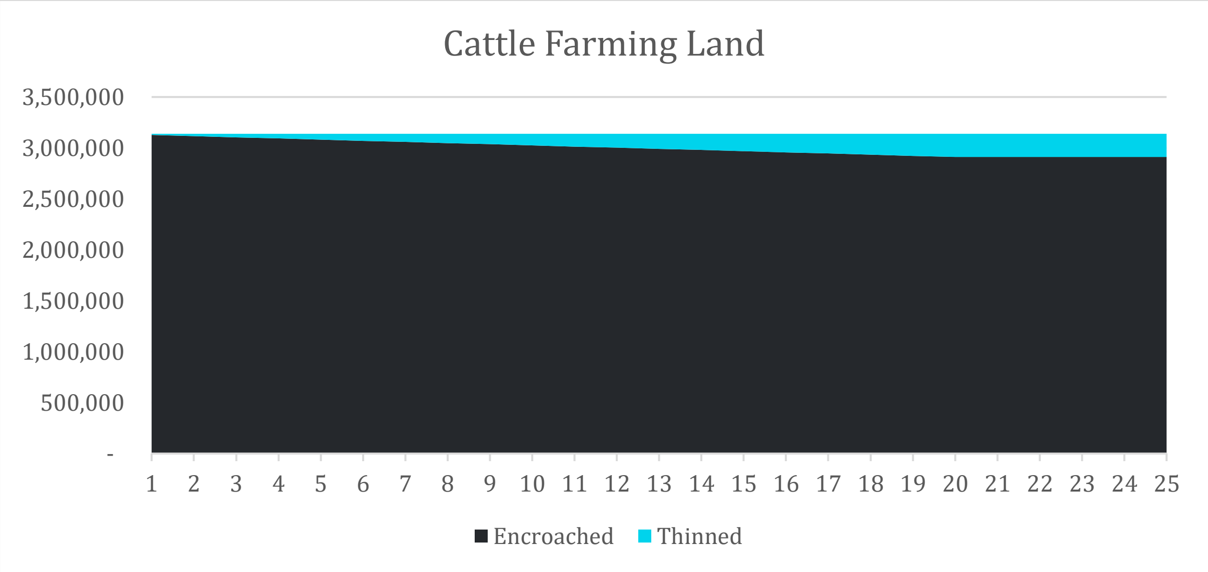
Scenario:

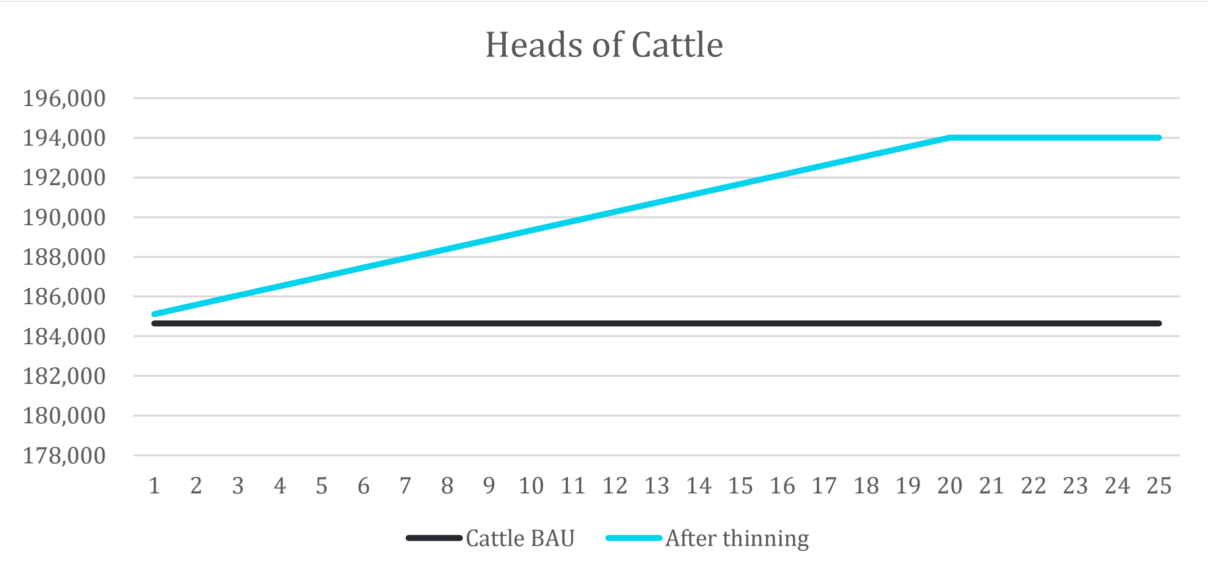
- Power station = 40MWe
- Capacity Factor = 50%
- Price per kWh installed = USD 3500/kW

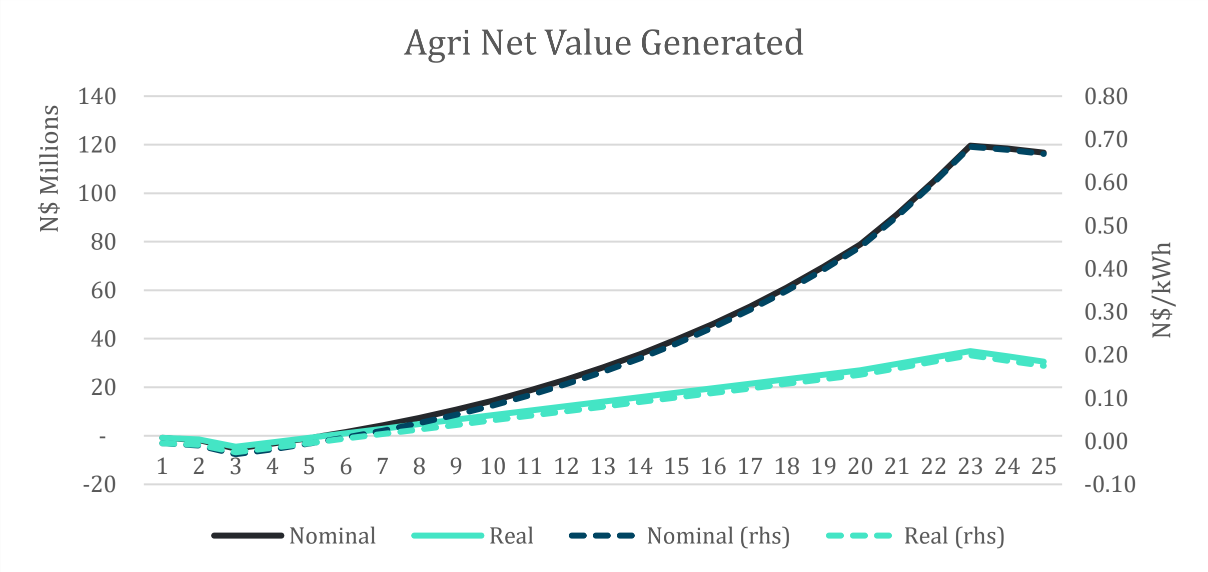





Direct Wages (nominal)
N$ Millions
N$/kWh
120
100
80
60
40
20
-
0.70
0.60
0.50
0.40
0.30
0.20
0.10
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
Harvester
Power Plant


Cattle Farming Land
3,500,000
3,000,000
2,500,000
2,000,000
1,500,000
1,000,000
500,000
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
Encroached
Thinned


Heads of Cattle
196,000
194,000
192,000
190,000
188,000
186,000
184,000
182,000
180,000
178,000
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
Cattle BAU
After thinning

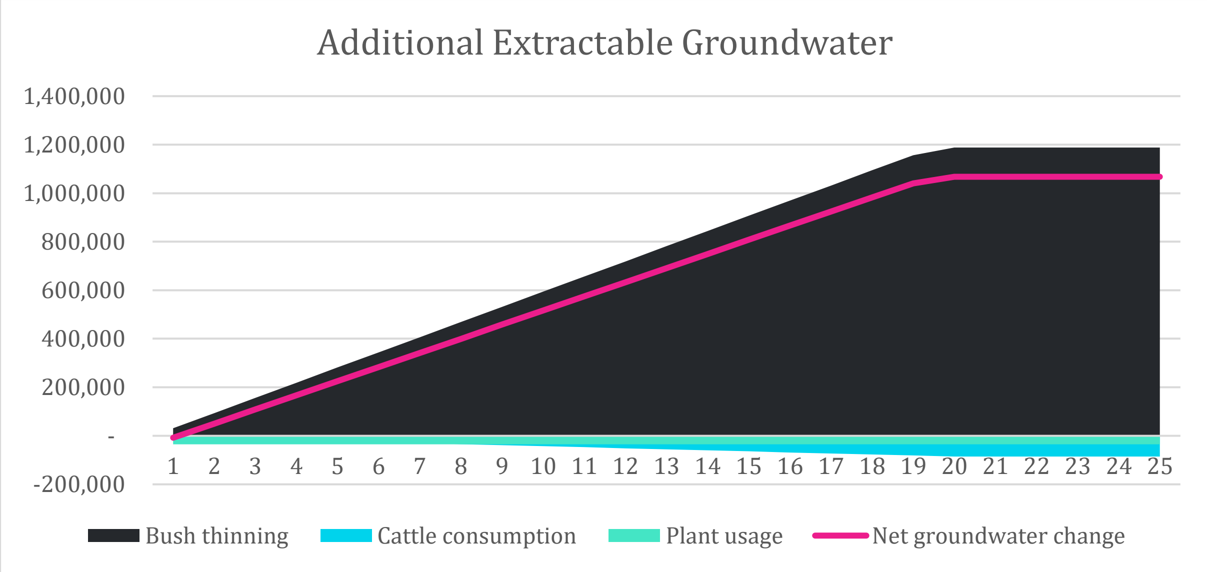


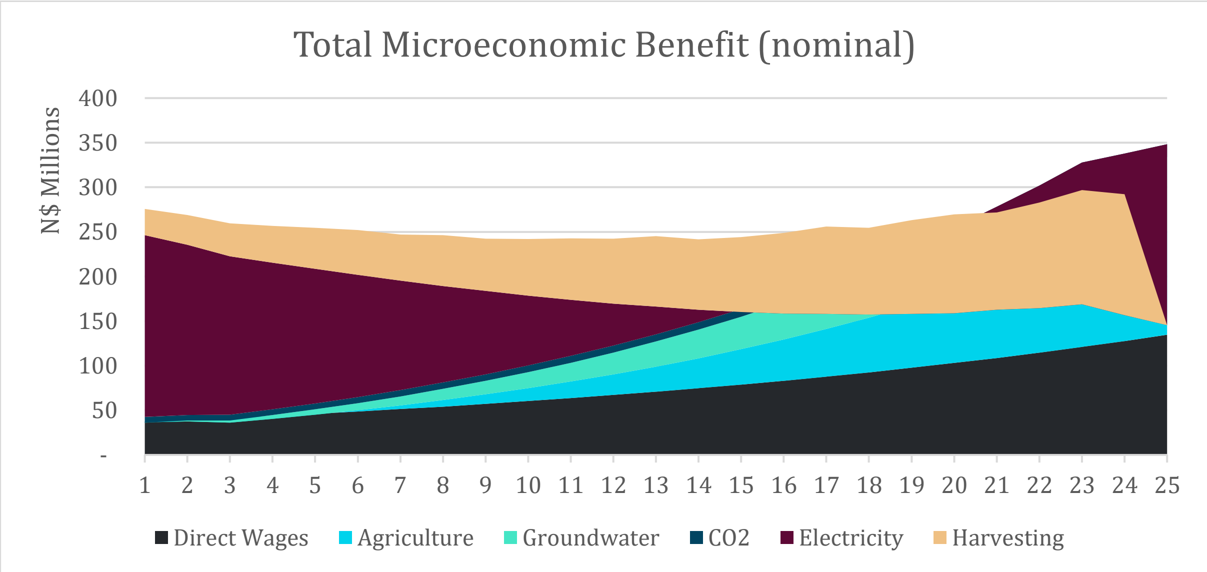
Activity	**kgCO₂e over 25 Years (per power station)**	**kgCO₂e / kWh**
Harvesting	97,172,854	0.022
Transport	12,529,000	0.003
Conversion	65,700,003	0.015
Soil Carbon	166,564,899	0.038
Livestock	514,265,043	0.117
Total	**856,231,798**	**0.195**

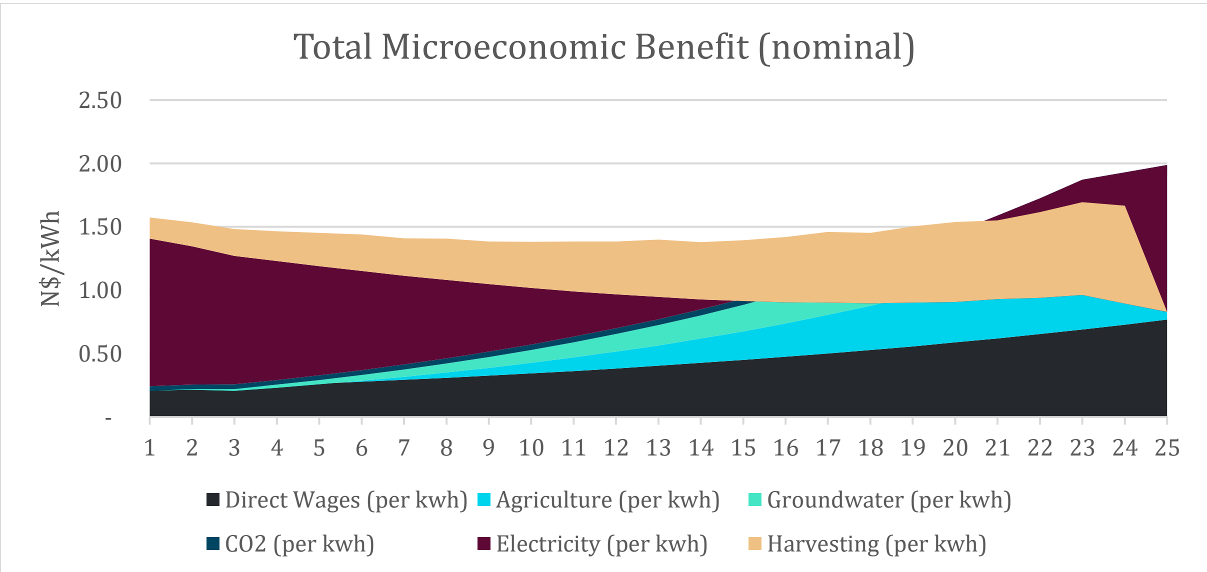
	$kgCO_2e$ over 25 Years			
Grid Emission Factor	**Emitted**	**Displaced**	**Project Net**	**$KgCO_2$ per kWh**
Namibian Grid = 0.4898 (WSP)	856,231,798	-2,145,324,084	-1,289,092,286	-0.17
SAPP = 0.9644 (UNFCCC)		-3,041,472,119	-2,185,240,321	-0.29

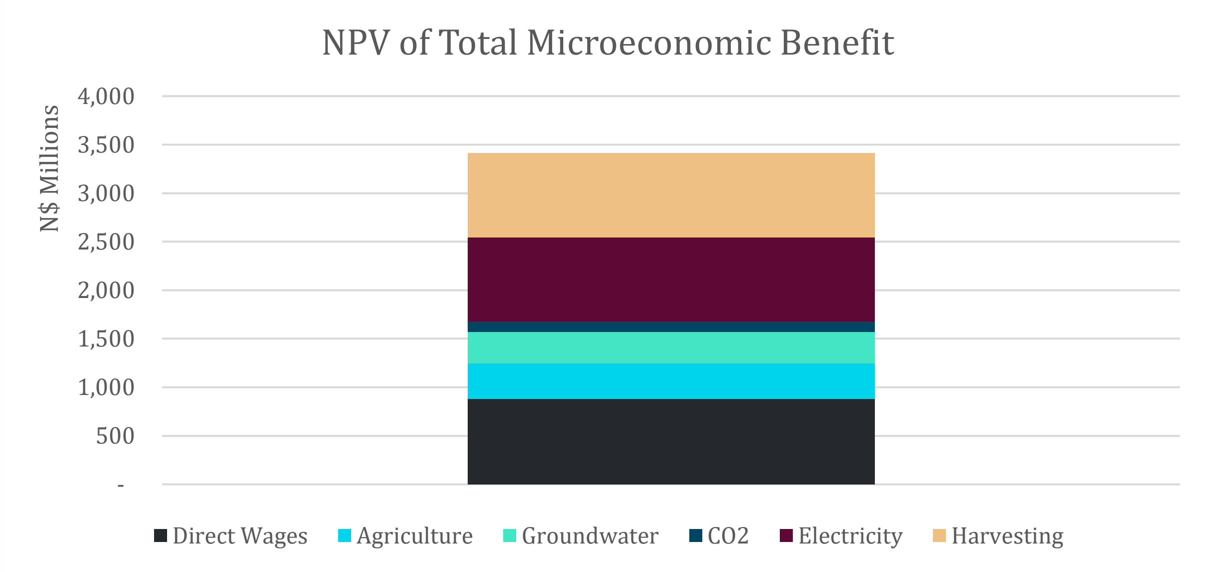
The overall value of net emissions, in constant prices, for the project amounts to:

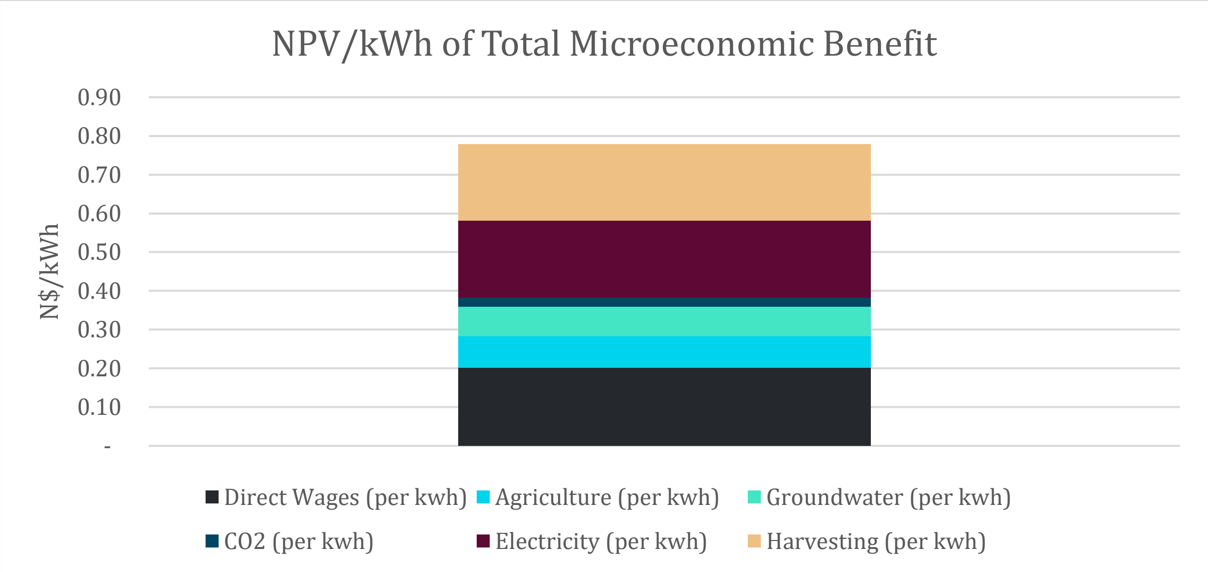
	Value of Net Emissions at beginning of operational period
Carbon Price	**NIRP NAD85**
NPV NAD	180,786,173.84
NAD/kWh	$1.03

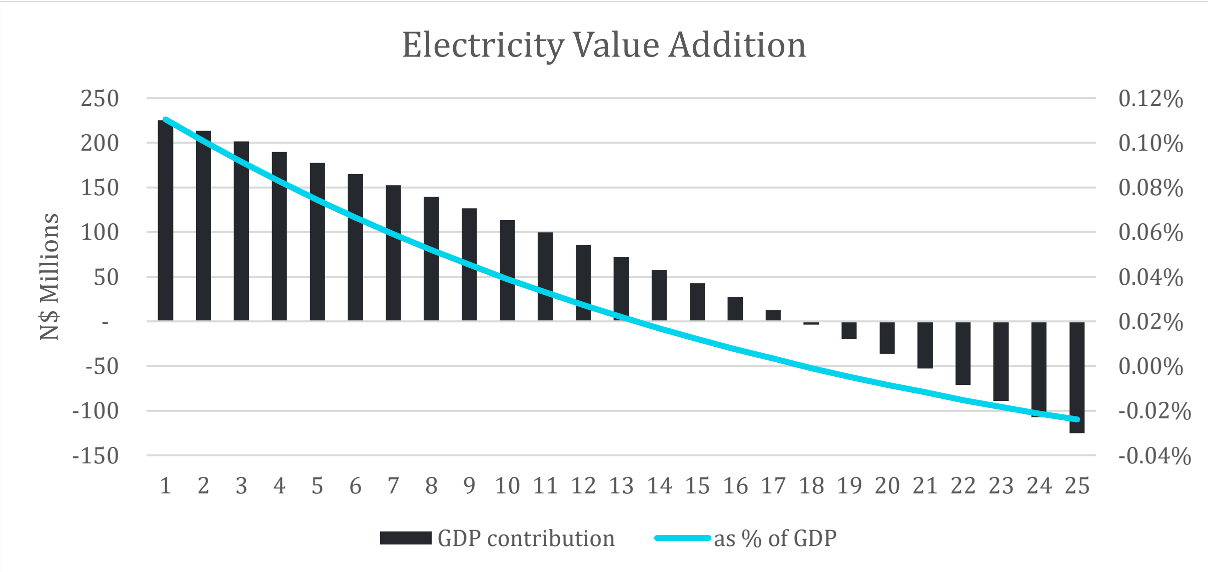

Additional Extractable Groundwater
1,400,000
1,200,000
1,000,000
800,000
600,000
400,000
200,000
-
-200,000
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
Bush thinning
Cattle consumption
Plant usage
Net groundwater change

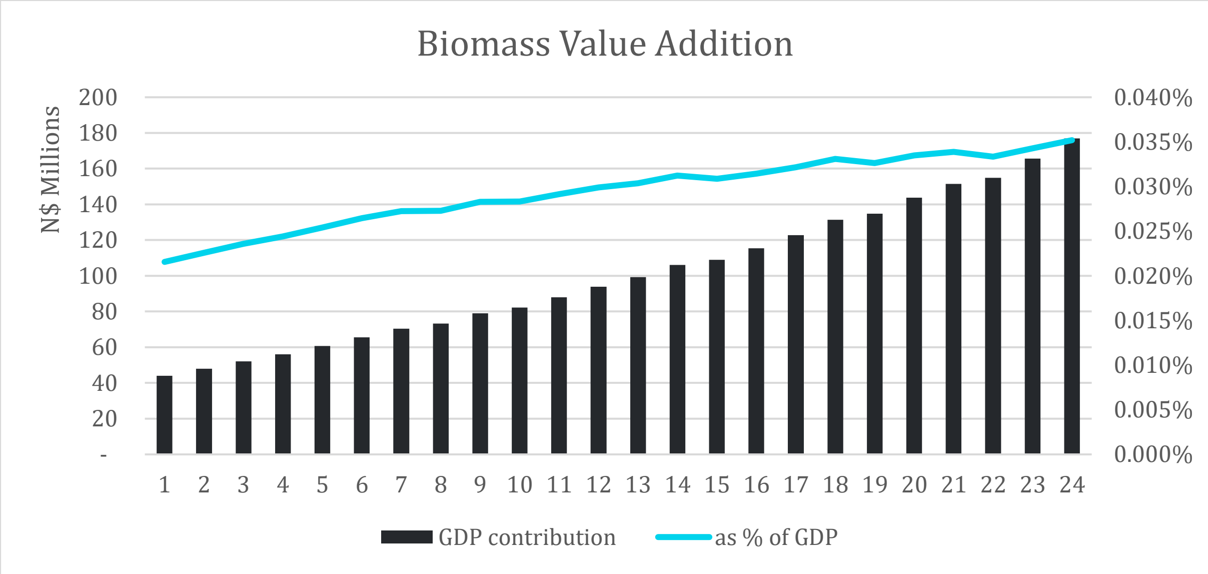

Total Microeconomic Benefit (nominal)
N$ Millions
400
350
300
250
200
150
100
50
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
Direct Wages
Agriculture
Groundwater
CO2
Electricity
Harvesting

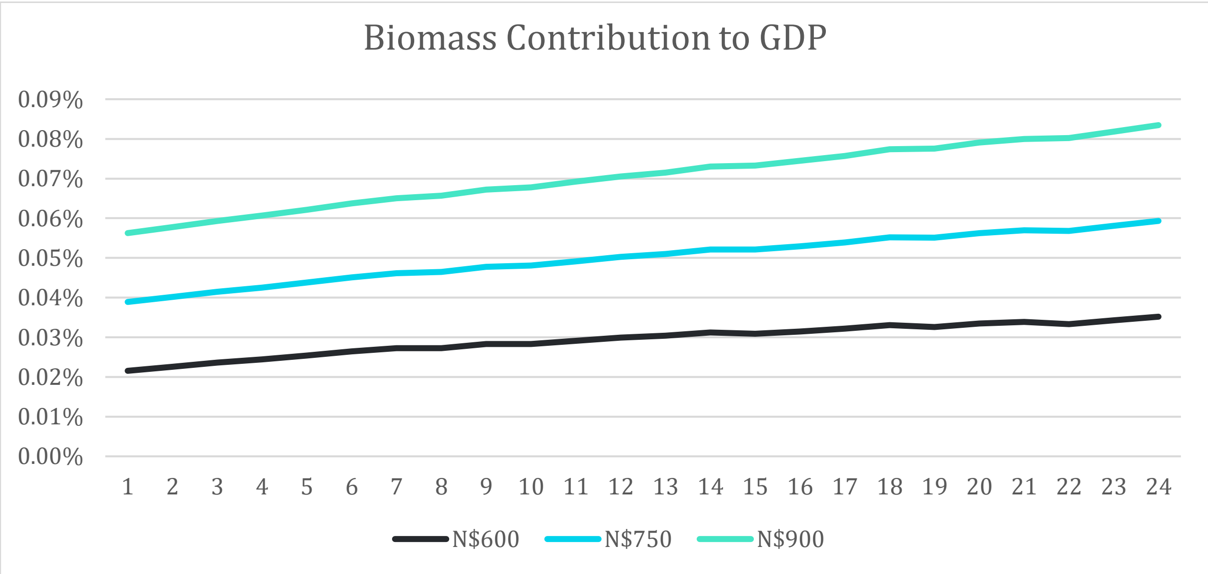

Total Microeconomic Benefit (nominal)
N$/kWh
2.50
2.00
1.50
1.00
0.50
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
Direct Wages (per kwh)
Agriculture (per kwh)
Groundwater (per kwh)
CO2 (per kwh)
Electricity (per kwh)
Harvesting (per kwh)

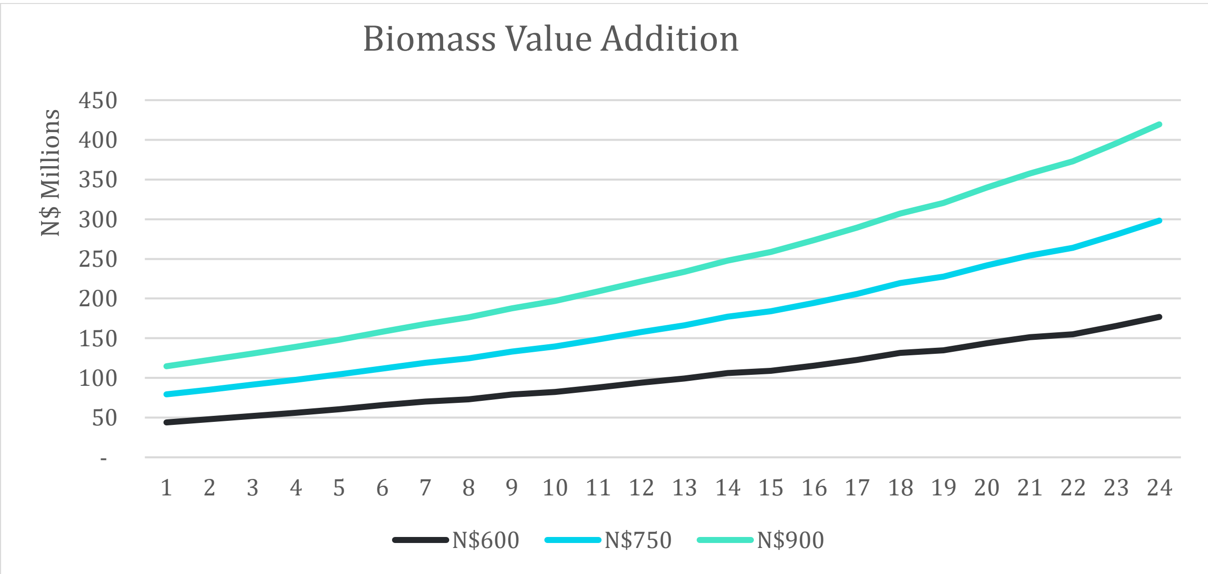

NPV of Total Microeconomic Benefit
N$ Millions
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
-
Direct Wages
Agriculture
Groundwater
CO2
Electricity
Harvesting

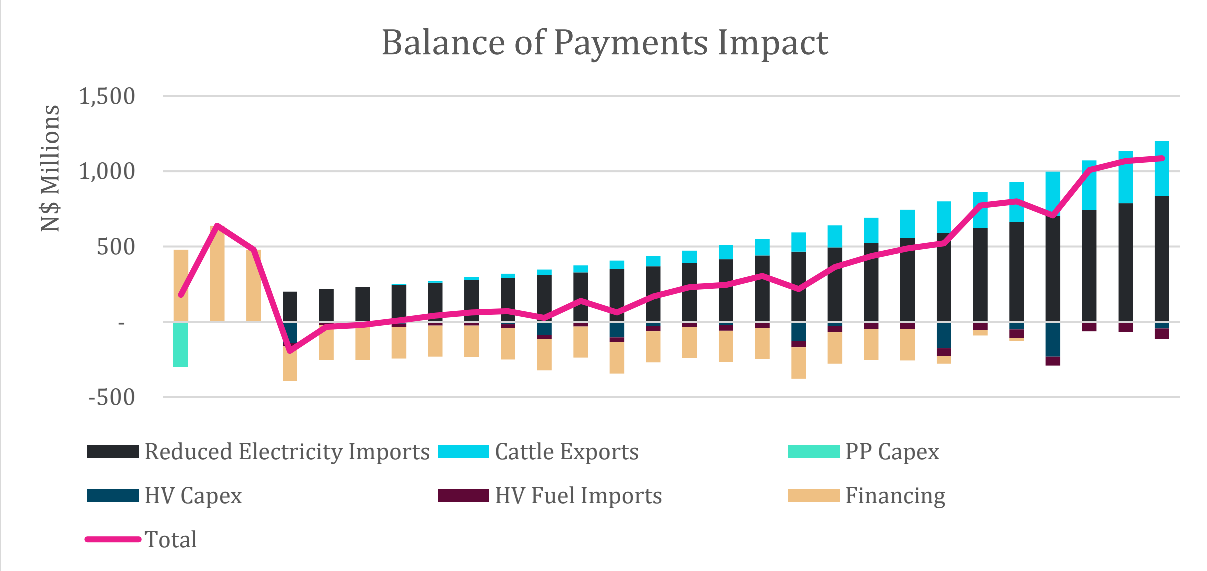

NPV/kWh of Total Microeconomic Benefit
N$/kWh
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
-
Direct Wages (per kwh)
Agriculture (per kwh)
Groundwater (per kwh)
CO2 (per kwh)
Electricity (per kwh)
Harvesting (per kwh)


Electricity Value Addition
N$ Millions
250
200
150
100
50
-
-50
-100
-150
0.12%
0.10%
0.08%
0.06%
0.04%
0.02%
0.00%
-0.02%
-0.04%
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
GDP contribution
as % of GDP

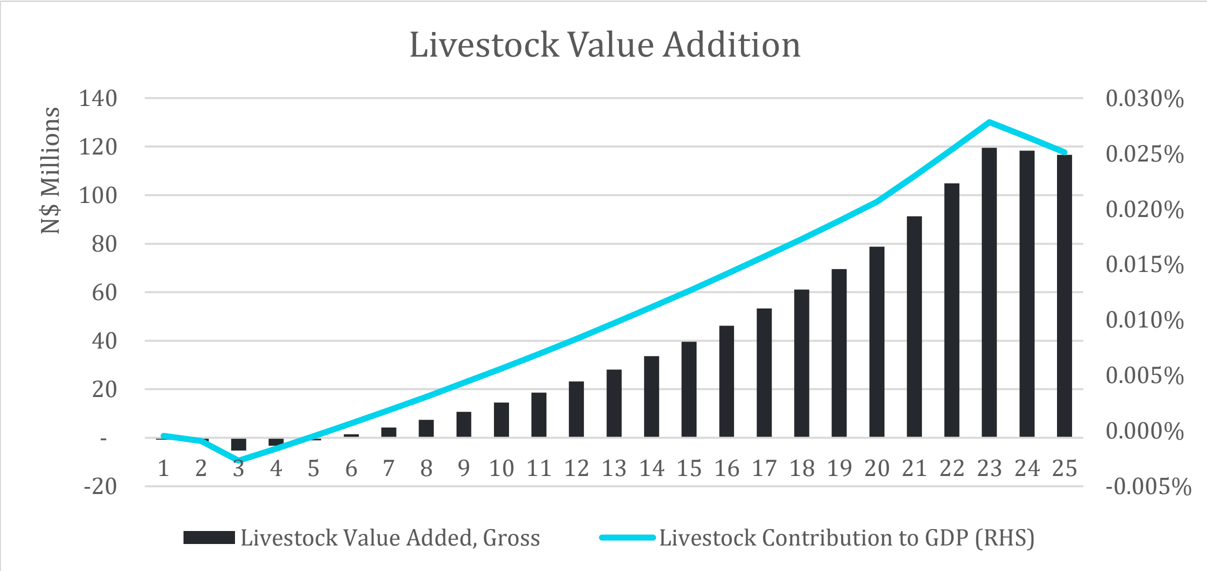

Biomass Value Addition
N$ Millions
200
180
160
140
120
100
80
60
40
20
-
0.040%
0.035%
0.030%
0.025%
0.020%
0.015%
0.010%
0.005%
0.000%
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
GDP contribution
as % of GDP


Biomass Contribution to GDP
0.09%
0.08%
0.07%
0.06%
0.05%
0.04%
0.03%
0.02%
0.01%
0.00%
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
N$600
N$750
N$900

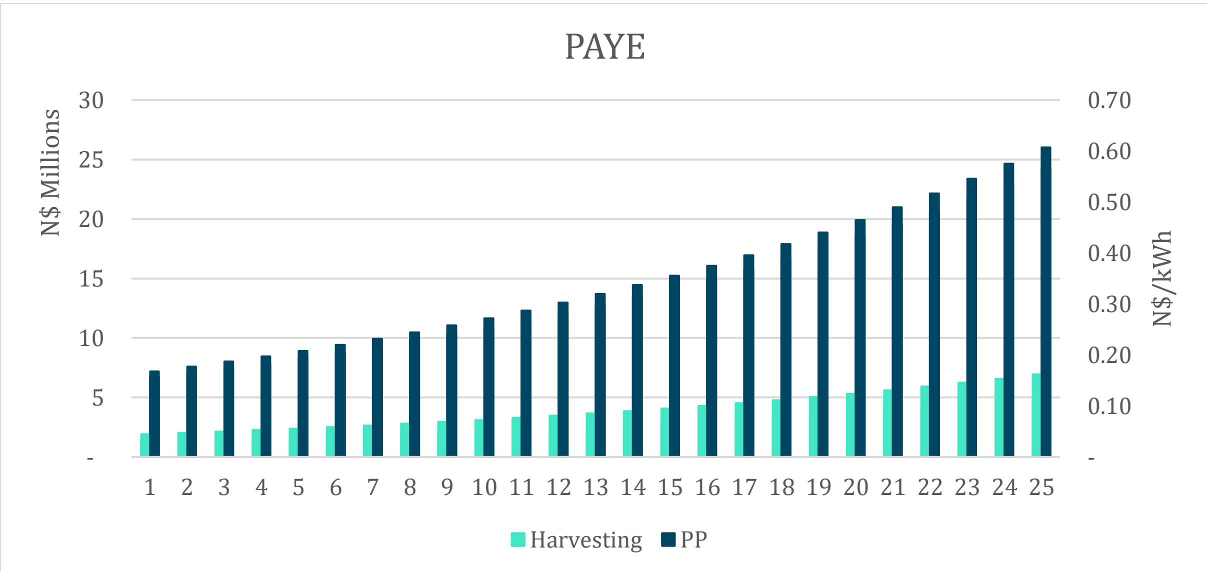

Biomass Value Addition
N$ Millions
450
400
350
300
250
200
150
100
50
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
N$600
N$750
N$900



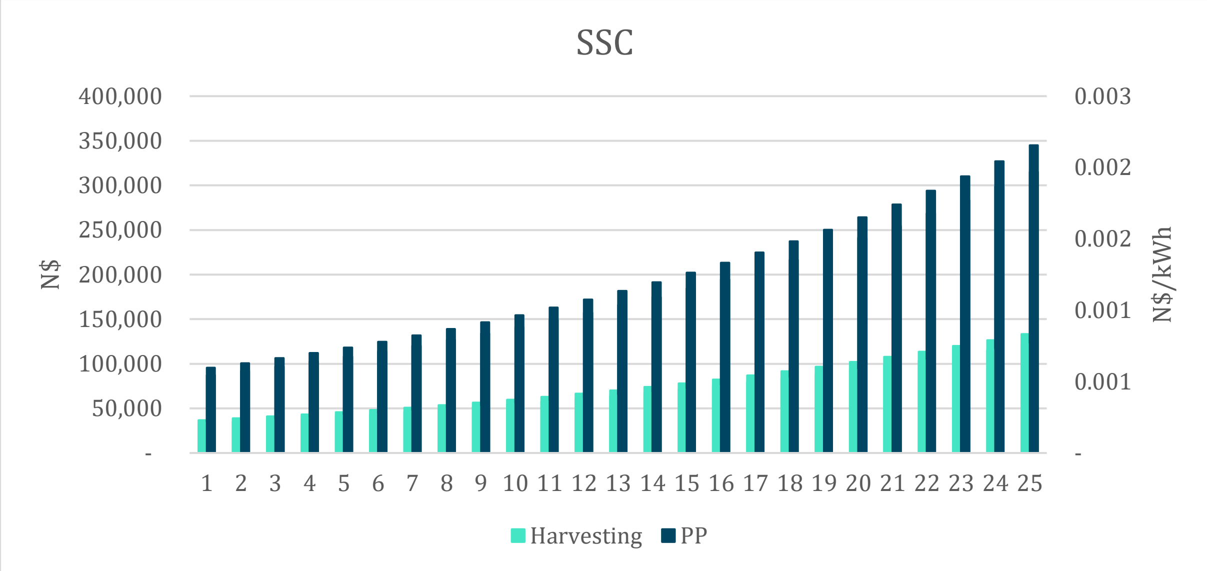
Balance of Payments Impact
N$ Millions
1,500
1,000
500
-
-500
Reduced Electricity Imports
Cattle Exports
PP Capex
HV Capex
HV Fuel Imports
Financing
Total

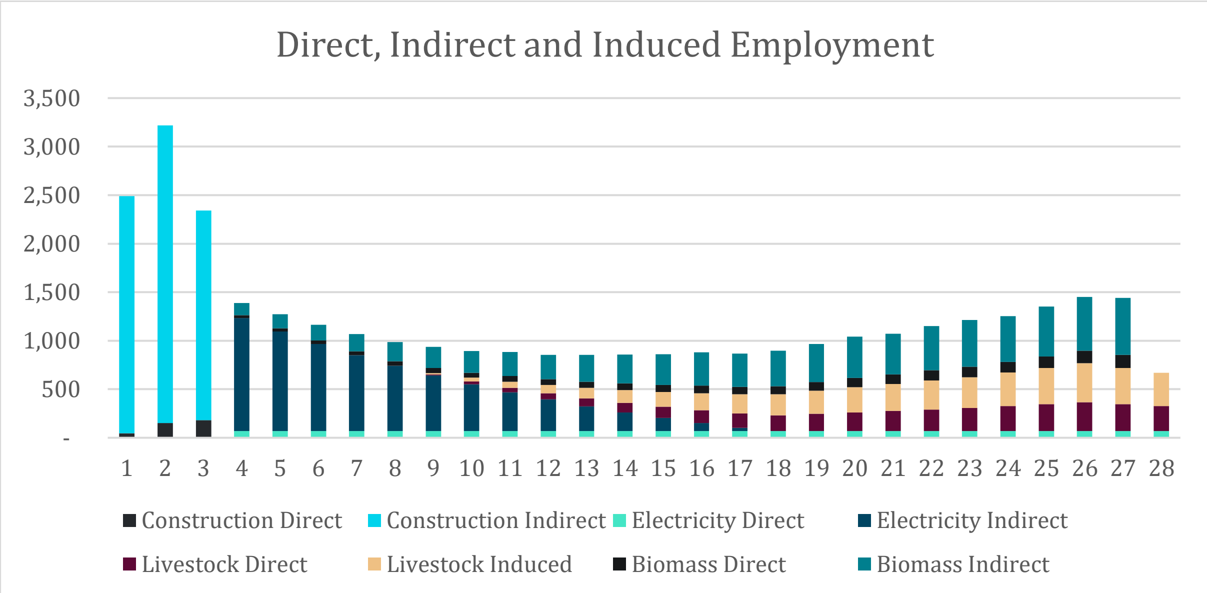


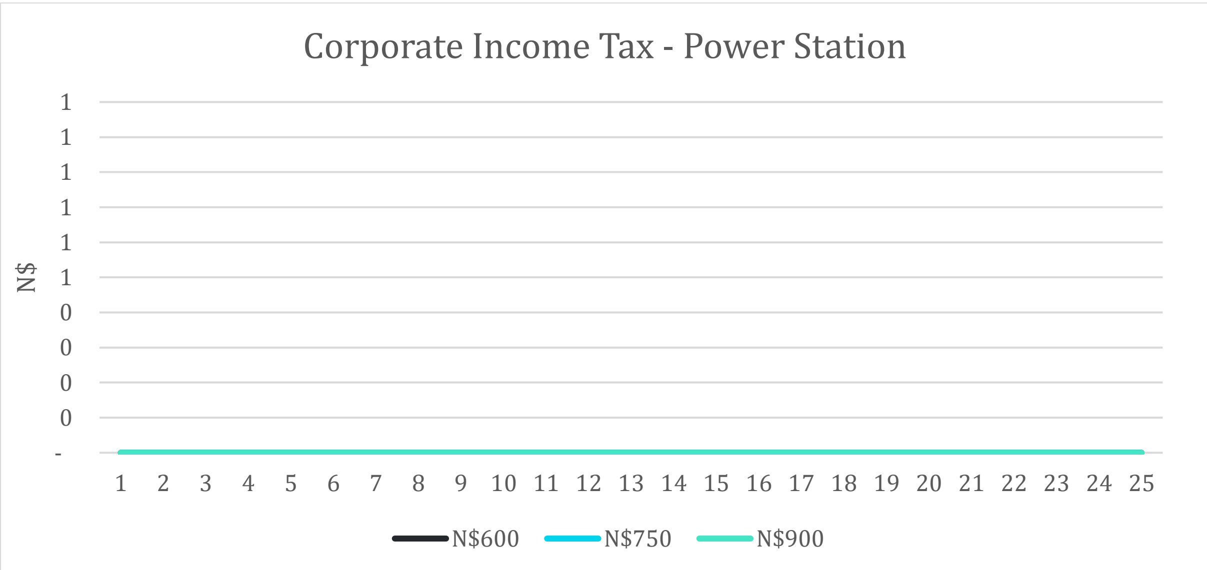
Livestock Value Addition
N$ Millions
140
120
100
80
60
40
20
-
-20
0.030%
0.025%
0.020%
0.015%
0.010%
0.005%
0.000%
-0.005%
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
Livestock Value Added, Gross
Livestock Contribution to GDP (RHS)

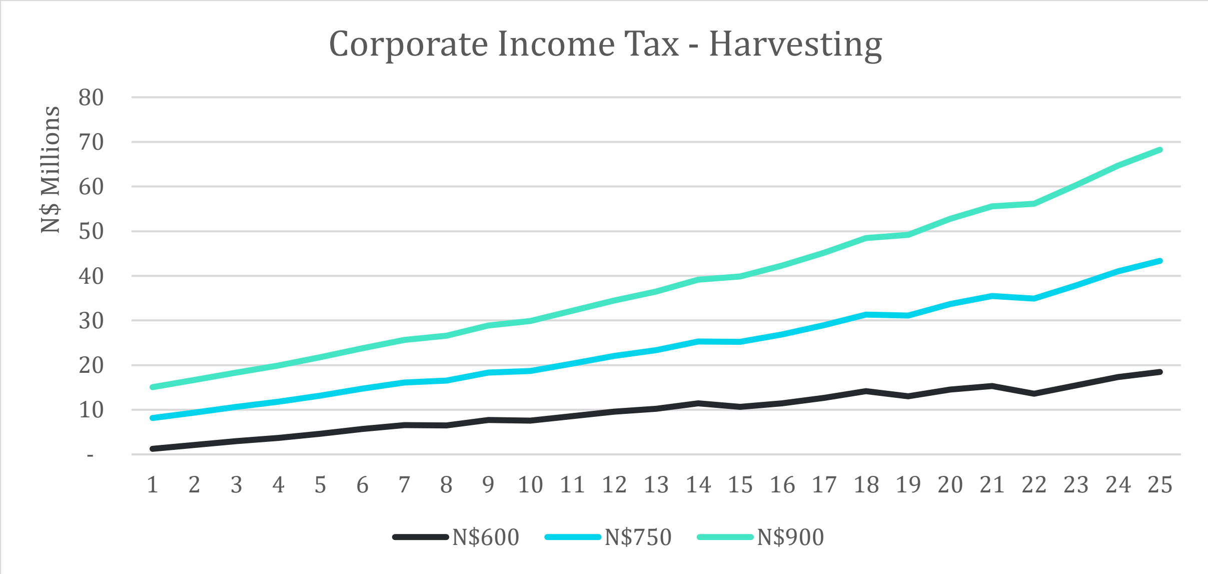


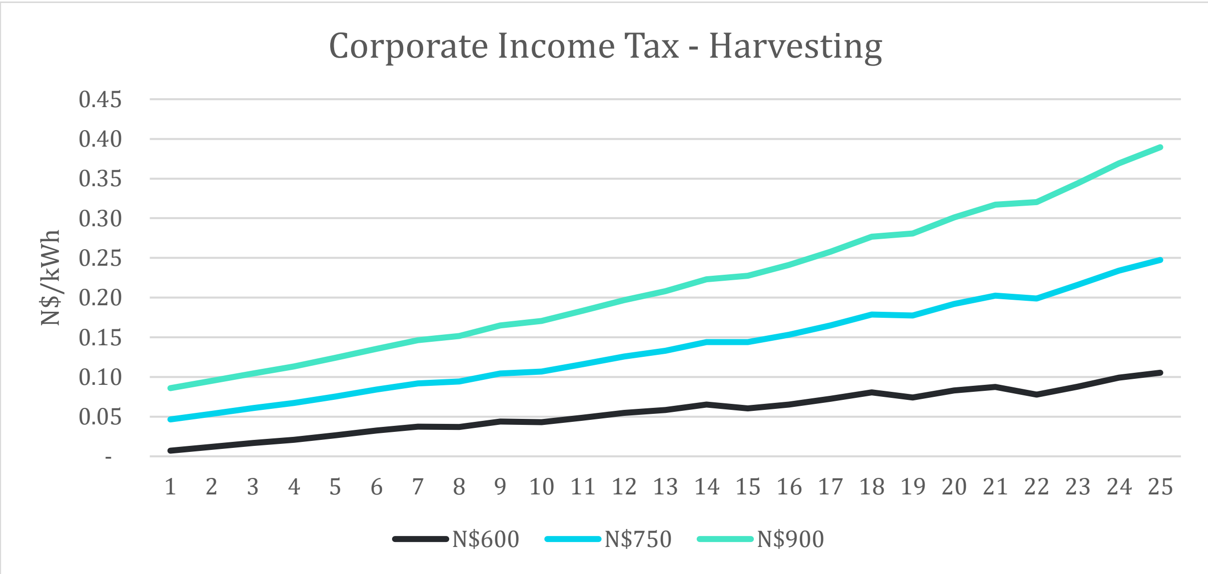
PAYE
N$ Millions
30
25
20
15
10
5
-
0.70
0.60
0.50
0.40
0.30
0.20
0.10
-
N$/kWh
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
Harvesting
PP

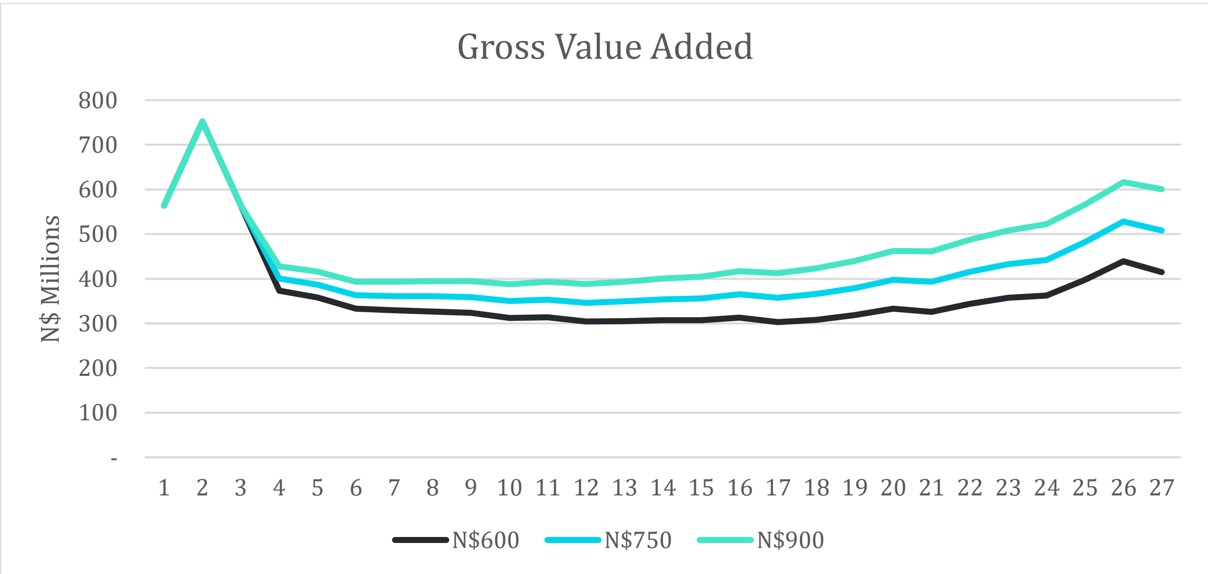

SSC
N$
N$/kWh
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
-
0.003
0.002
0.002
0.001
0.001
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
Harvesting
PP

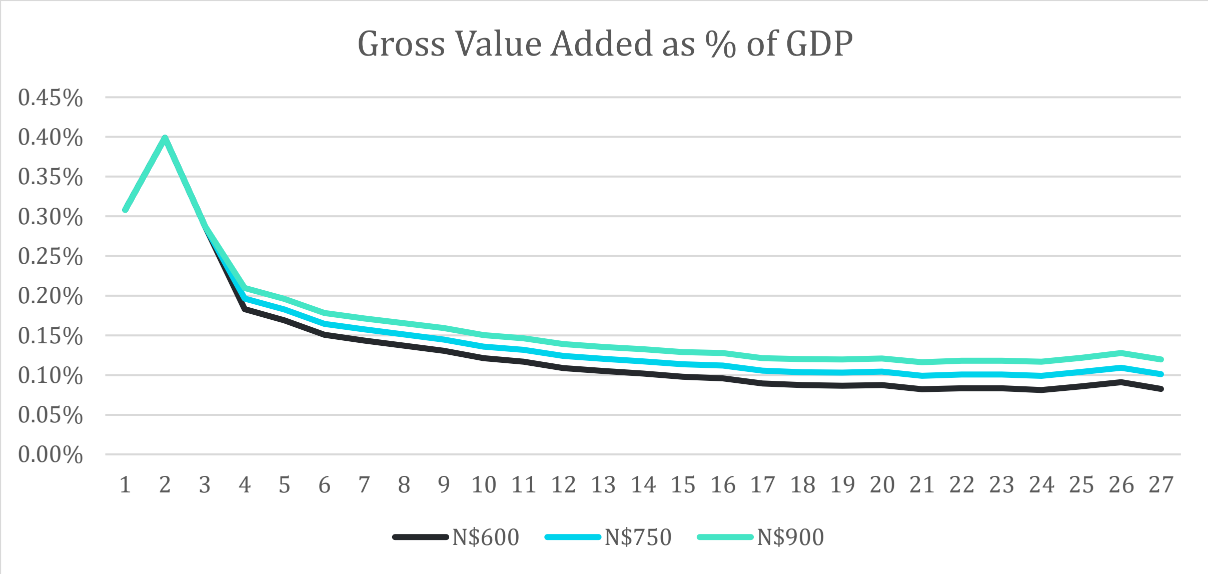

Direct, Indirect and Induced Employment
3,500
3,000
2,500
2,000
1,500
1,000
500
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28
Construction Direct
Construction Indirect
Electricity Direct
Electricity Indirect
Livestock Direct
Livestock Induced
Biomass Direct
Biomass Indirect

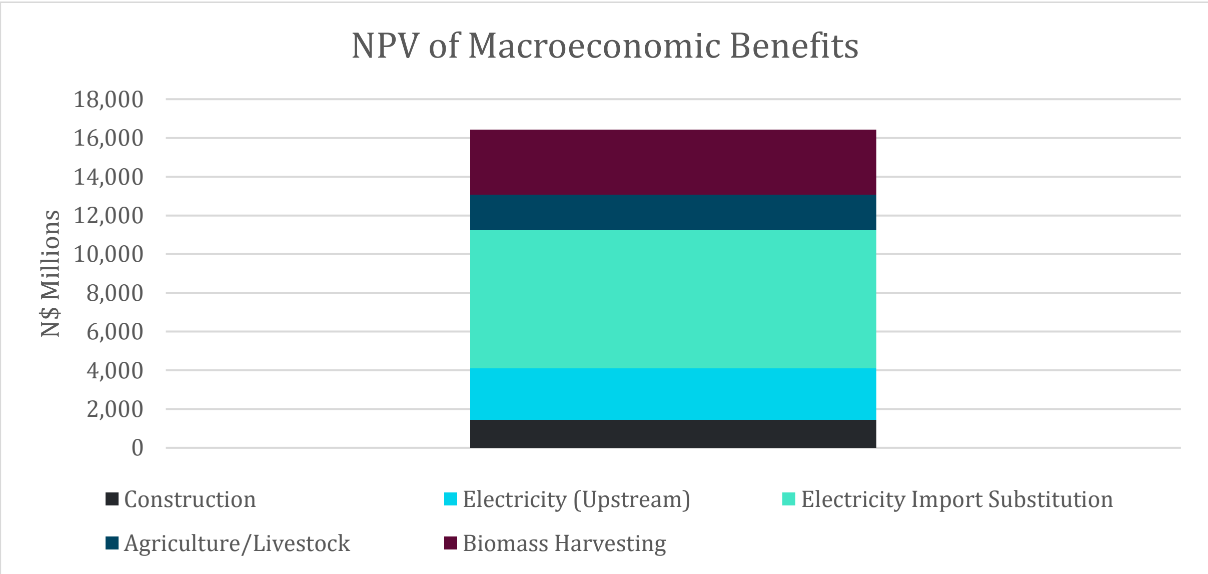

Corporate Income Tax - Power Station
N$
1
1
1
1
1
1
0
0
0
0
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
N$600
N$750
N$900

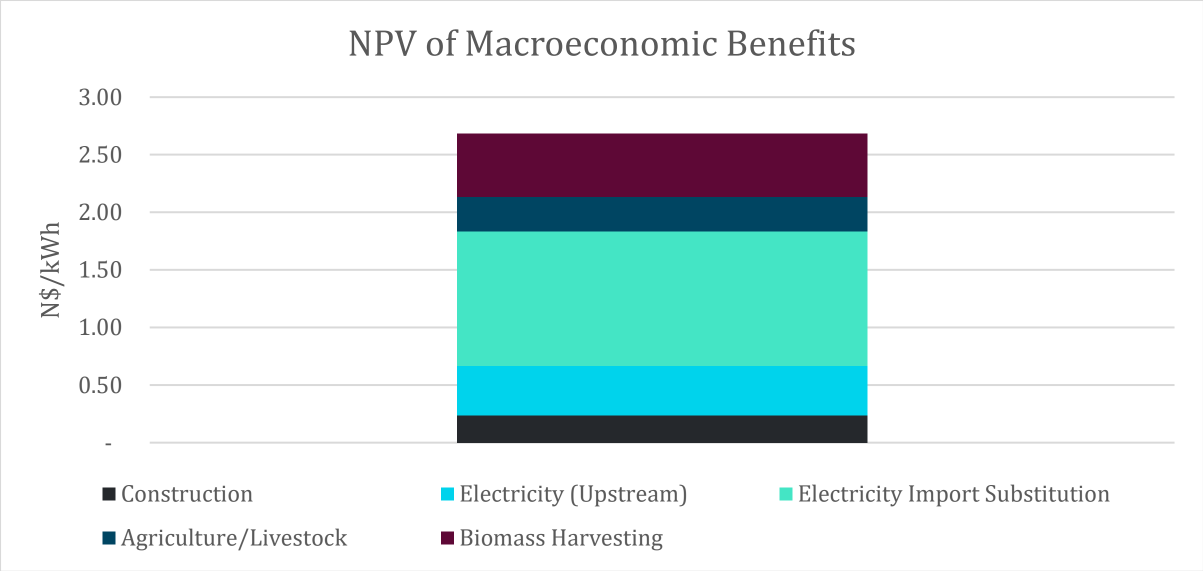

Corporate Income Tax - Harvesting
N$ Millions
80
70
60
50
40
30
20
10
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
N$600 N$750 N$900


Corporate Income Tax - Harvesting
N$/kWh
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
N$600 N$750 N$900


Gross Value Added
N$ Millions
800
700
600
500
400
300
200
100
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27
N$600 N$750 N$900


Gross Value Added as % of GDP
0.45%
0.40%
0.35%
0.30%
0.25%
0.20%
0.15%
0.10%
0.05%
0.00%
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27
N$600
N$750
N$900


NPV of Macroeconomic Benefits
N$ Millions
18,000
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
Construction
Electricity (Upstream)
Electricity Import Substitution
Agriculture/Livestock
Biomass Harvesting

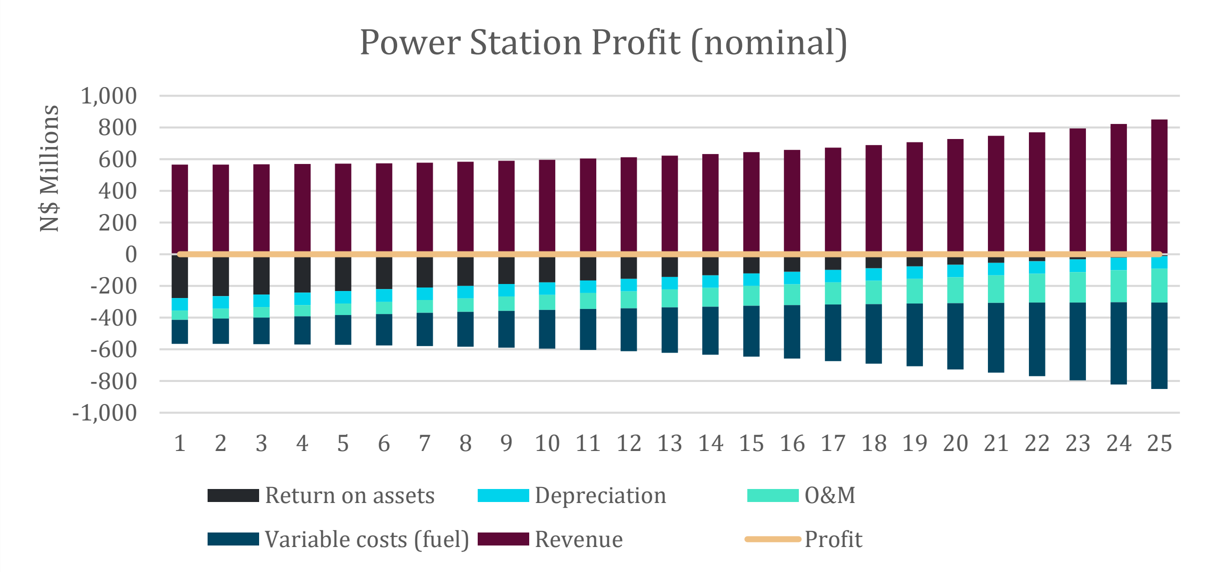

NPV of Macroeconomic Benefits
N$/kWh
3.00
2.50
2.00
1.50
1.00
0.50
-
Construction
Electricity (Upstream)
Electricity Import Substitution
Agriculture/Livestock
Biomass Harvesting

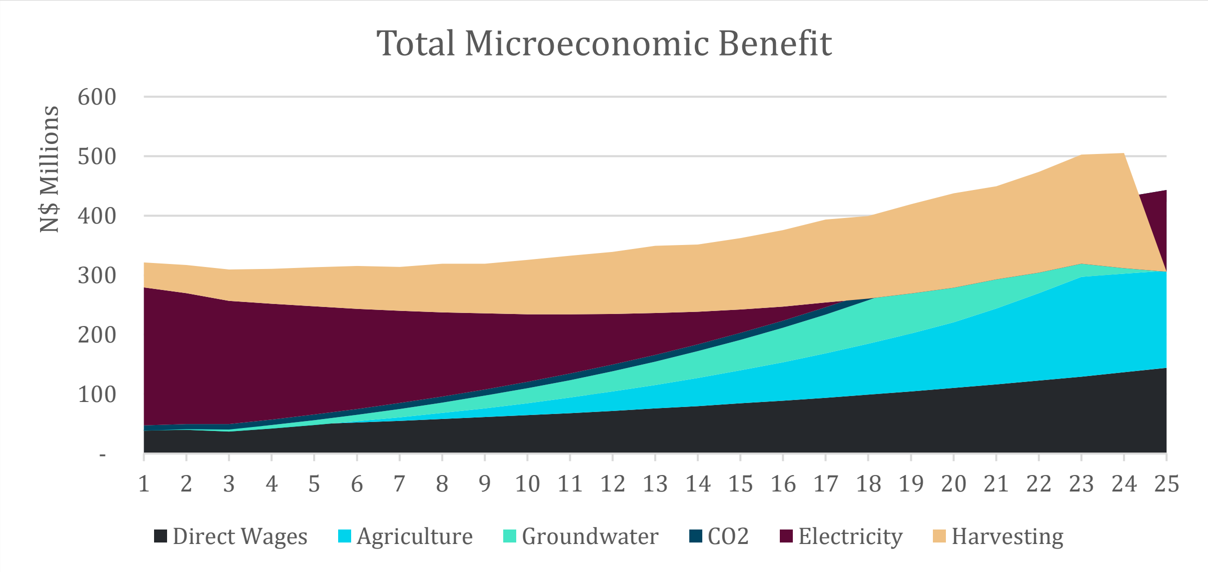
Appendix 3

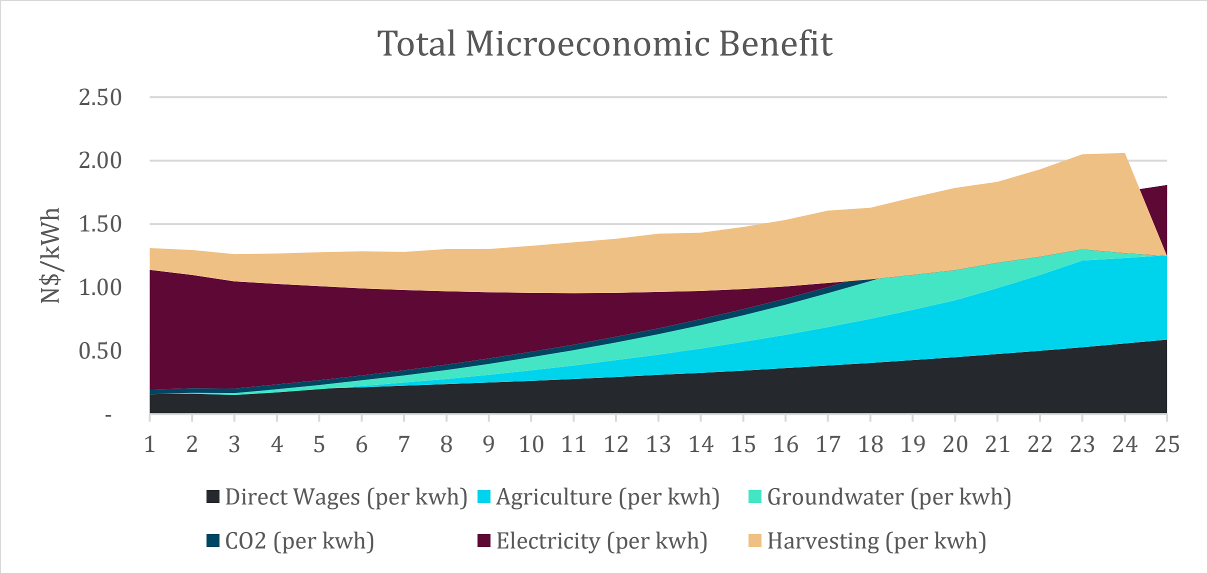
Scenario:

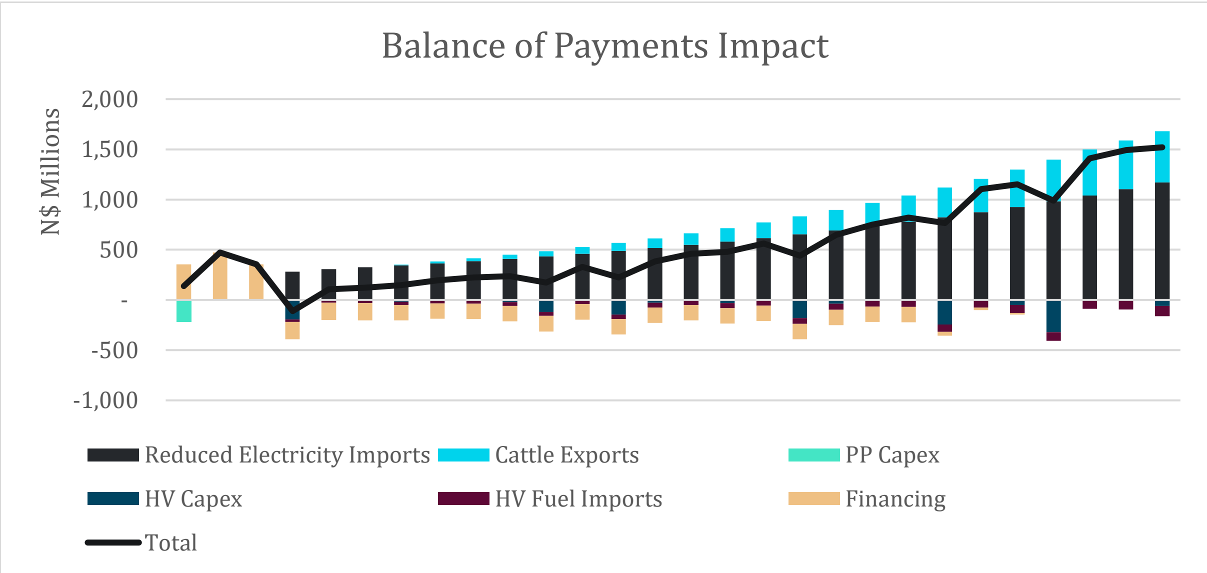
- Power station = 40MWe
- Capacity Factor = 70%
- Price per kWh installed = USD 3500/kW

As only the capex price has been varied, selected charts are inserted to illustrate the impact. The change in capex has no bearing on harvesting, agricultural and environmental outputs, employment, import substitution, etc.

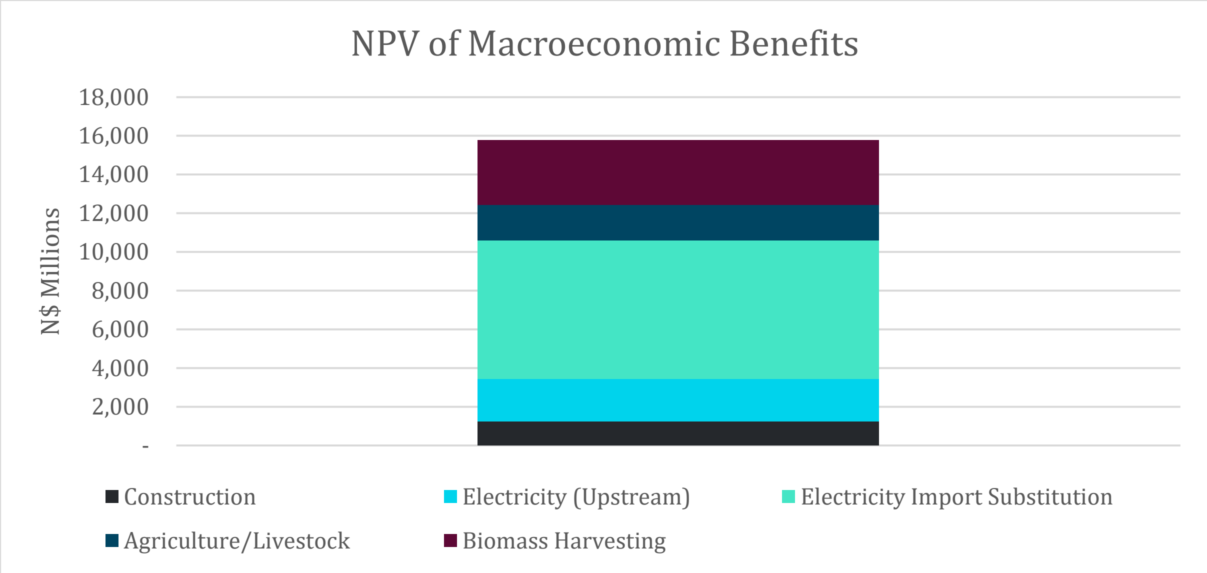


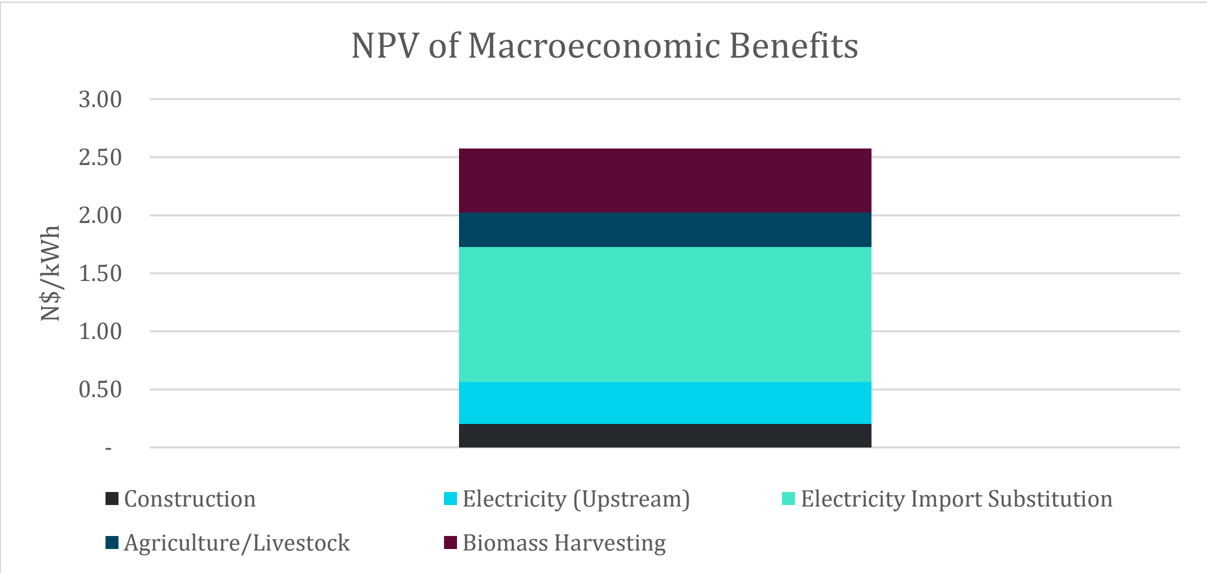






NAD Million	Multiplier	Year		
		1	2	3
Construction Value Addition, Gross		177.53	236.71	177.53
- Downstream	**0.21**	37.47	49.96	37.47
- Upstream	**2.15**	381.29	508.39	381.29
Total (Multiplied Value Addition)	**2.36**	418.76	558.35	418.76
Construction Value Addition to GDP		**0.097%**	**0.126%**	**0.091%**
Multiplied Value Addition to GDP		**0.229%**	**0.296%**	**0.214%**
Value addition/kWh		1.71	2.28	1.71
Value addition/kWh (real)		1.44	1.82	1.29

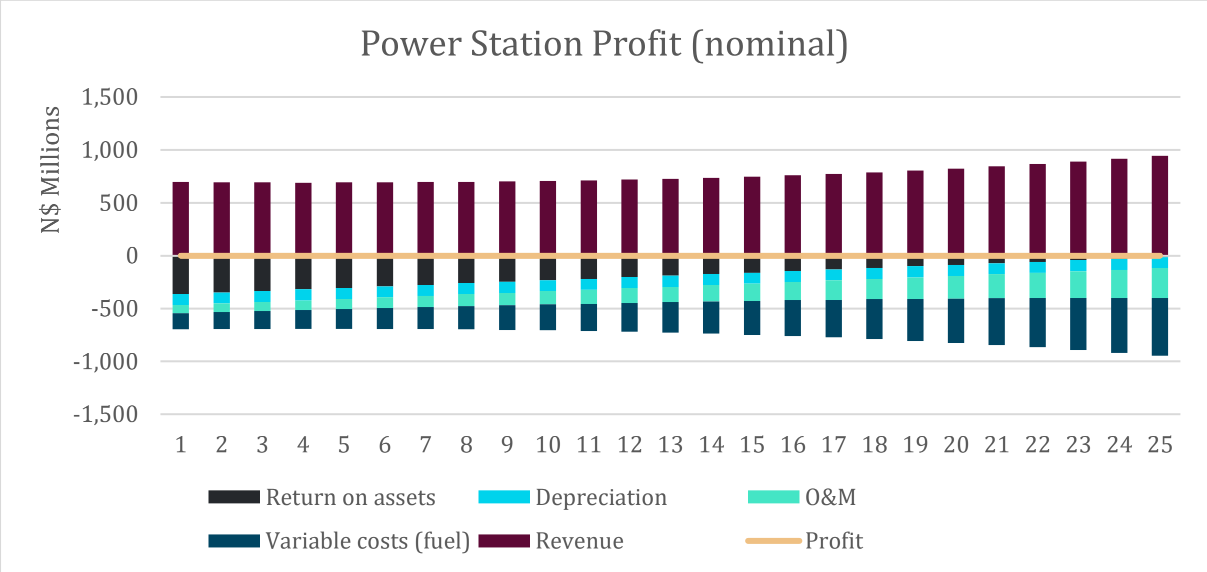

NPV of Macroeconomic Benefits
18,000
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
-
N$ Millions
Construction
Electricity (Upstream)
Electricity Import Substitution
Agriculture/Livestock
Biomass Harvesting

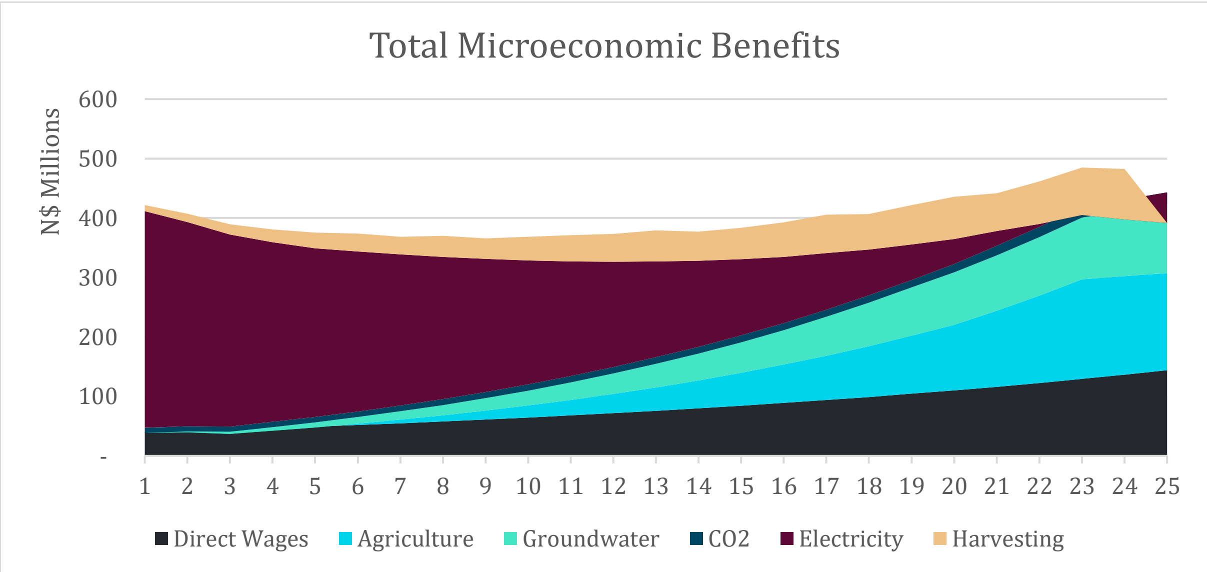

NPV of Macroeconomic Benefits
3.00
2.50
2.00
1.50
1.00
0.50
-
N$/kWh
Construction
Electricity (Upstream)
Electricity Import Substitution
Agriculture/Livestock
Biomass Harvesting

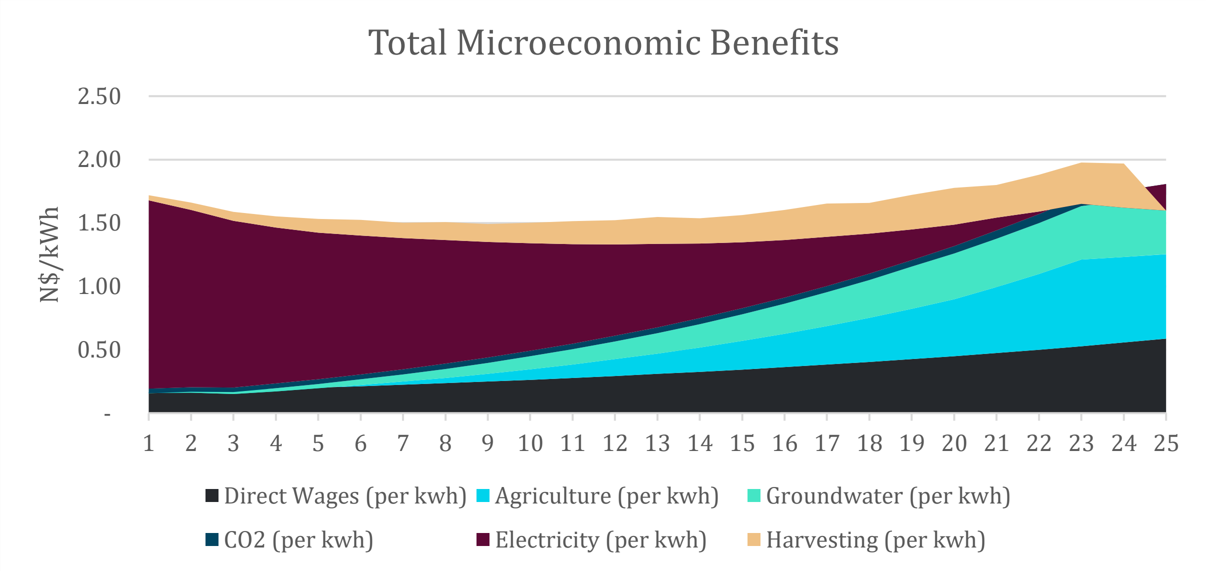
Appendix 4

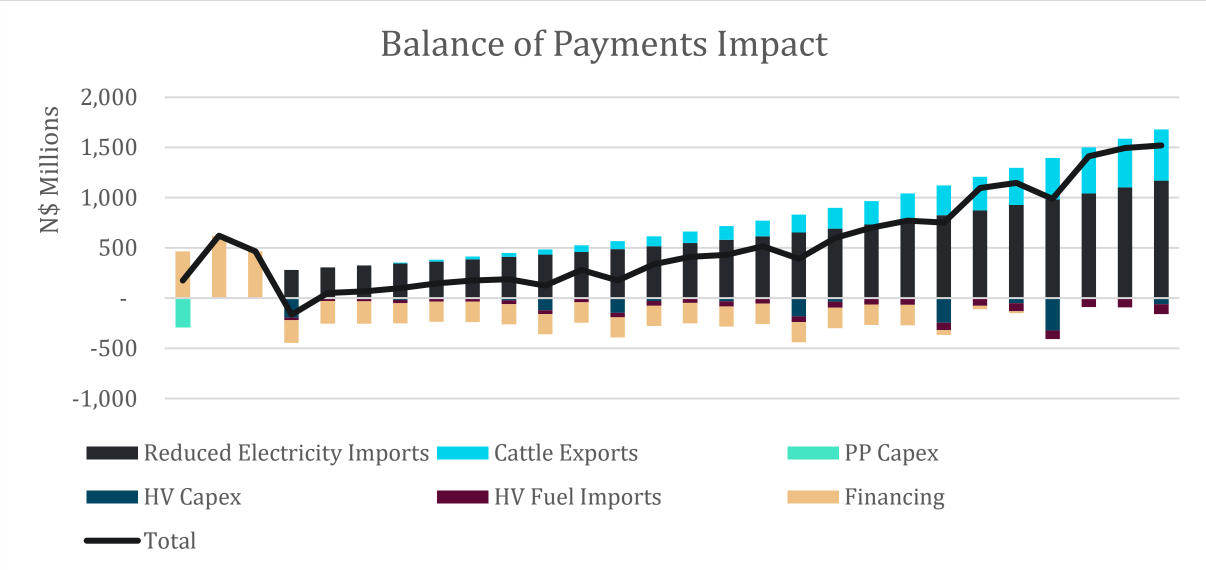
Scenario:

- Power station = 40MWe
- Capacity Factor = 70%
- Price per kWh installed = USD 4000/kW

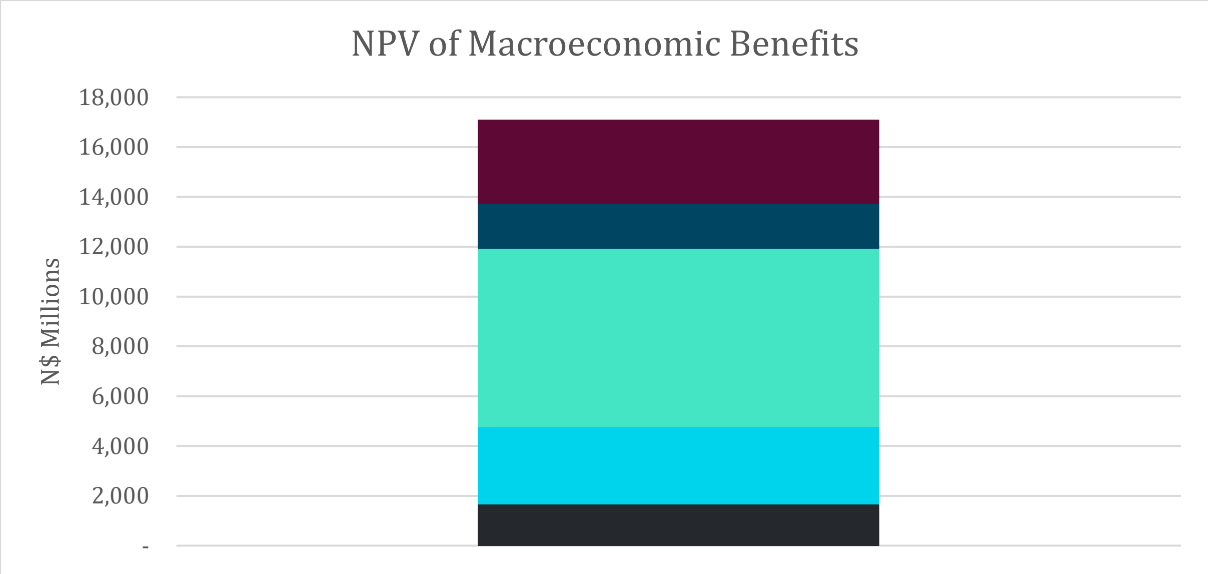


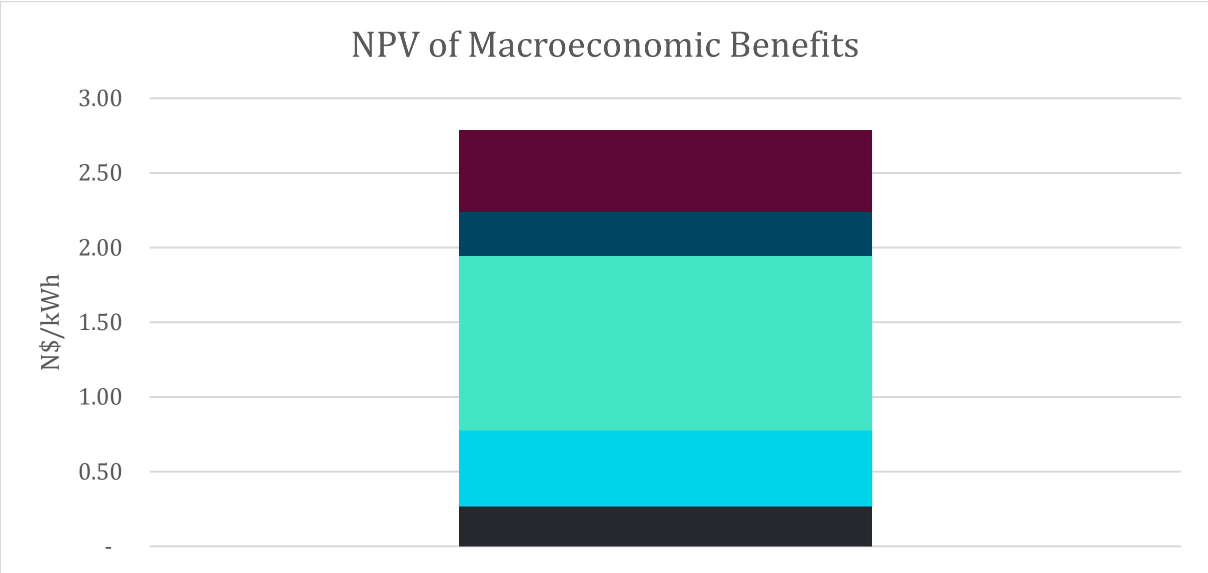






NAD Million	Multiplier	Year		
		1	2	3
Construction Value Addition, Gross		233.38	311.18	233.38
- Downstream	**0.21**	49.26	65.68	49.26
- Upstream	**2.15**	501.26	668.34	501.26
Total (Multiplied Value Addition)	**2.36**	550.51	734.02	550.51
Construction Value Addition to GDP		**0.127%**	**0.165%**	**0.119%**
Multiplied Value Addition to GDP		**0.301%**	**0.389%**	**0.281%**
Value addition/kWh		2.24	2.99	2.24
Value addition/kWh (real)		1.89	2.39	1.69

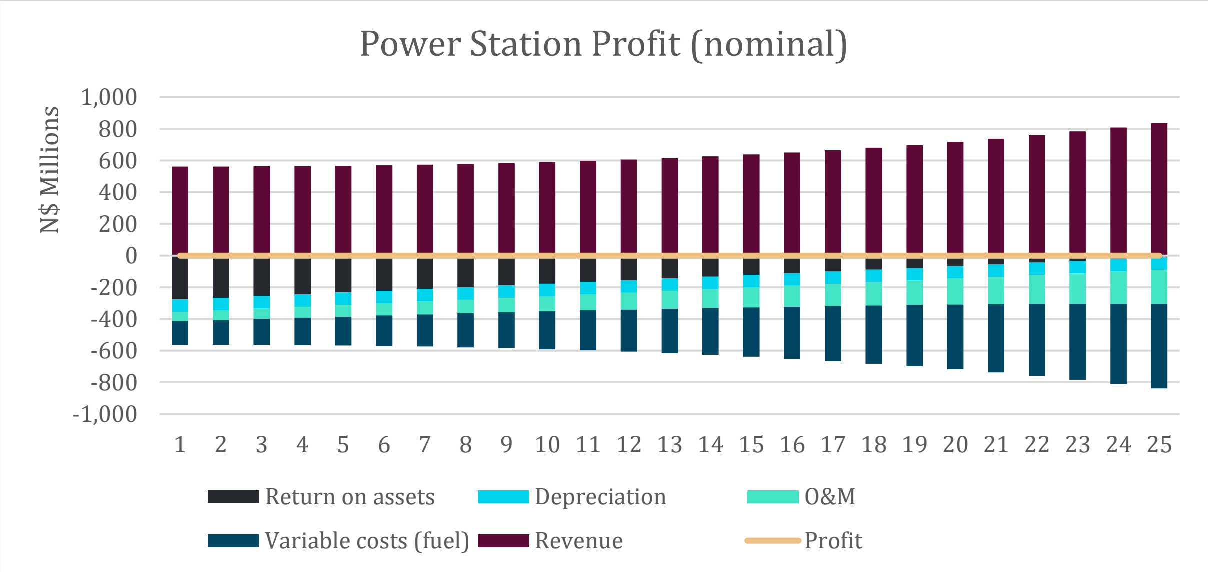

NPV of Macroeconomic Benefits
N$ Millions
18,000
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
-

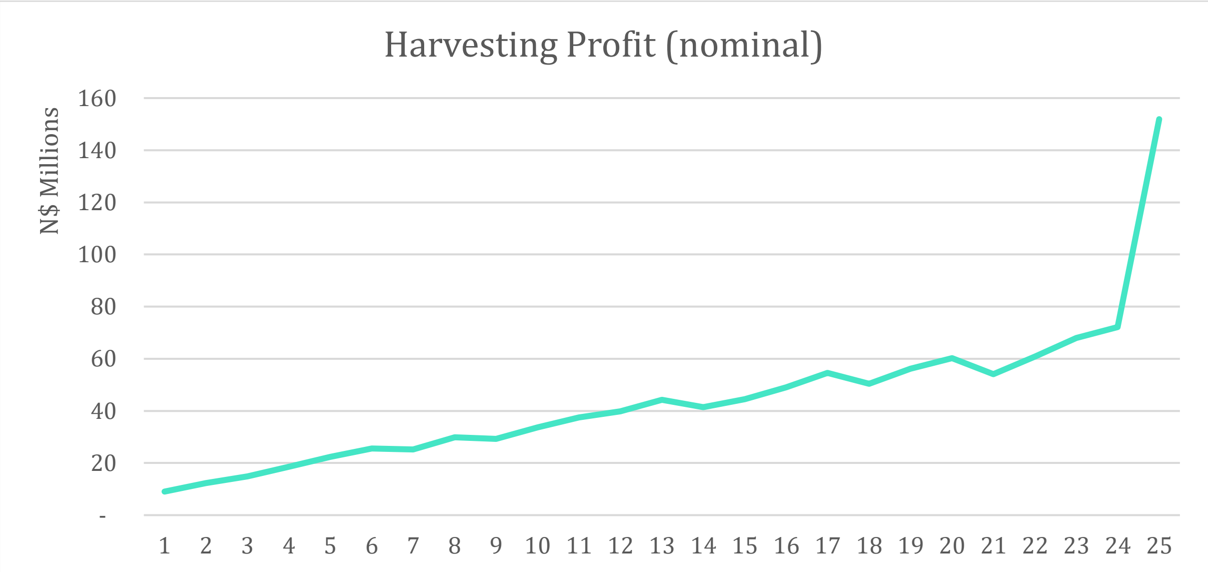

NPV of Macroeconomic Benefits
N$/kWh
3.00
2.50
2.00
1.50
1.00
0.50
-

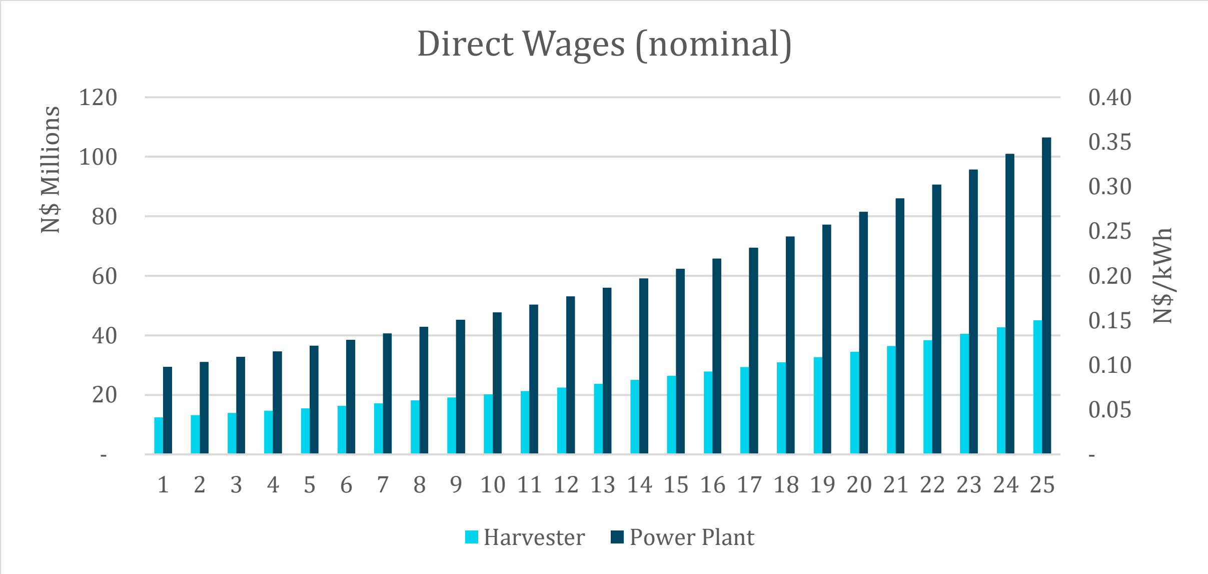
Appendix 5

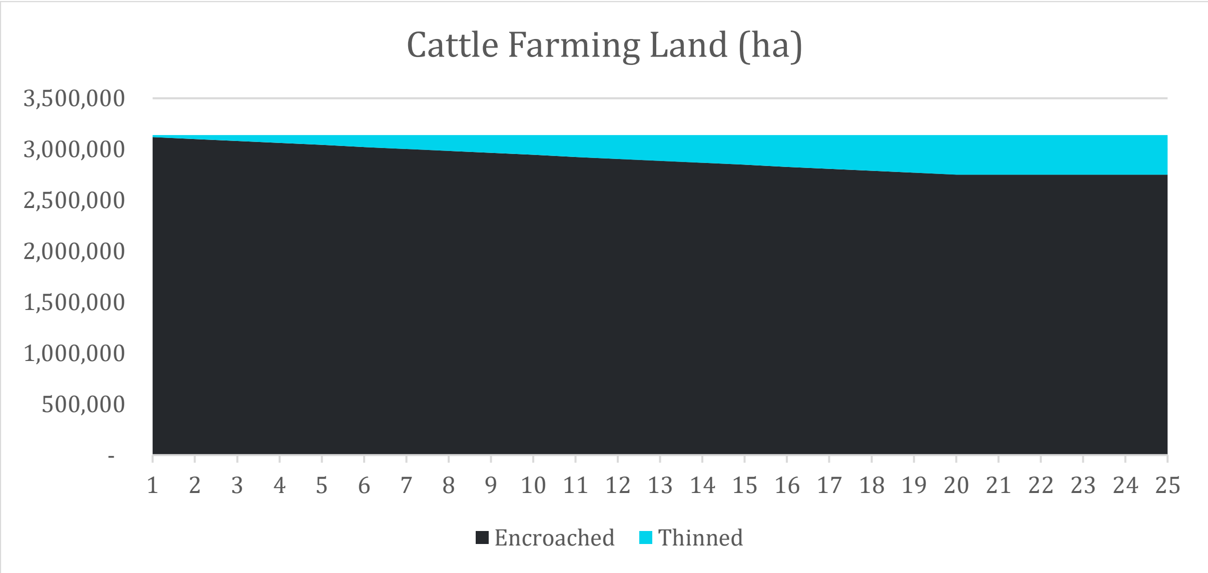
'Best Case' Scenario:

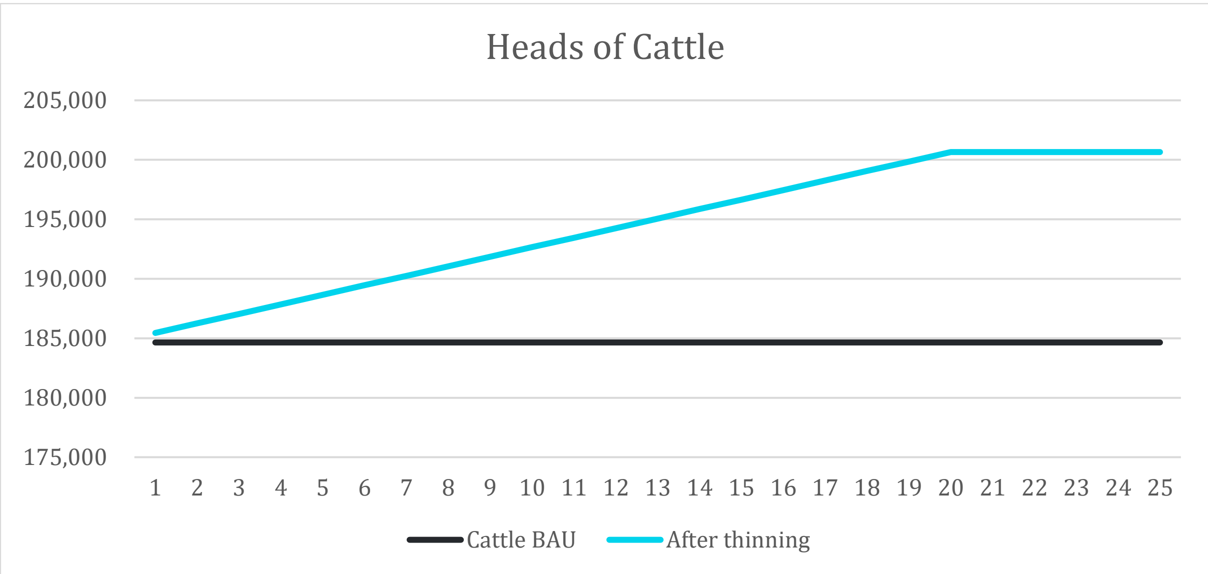
- Power station = 40MWe
- Capacity Factor = 85%
- Price per kWh installed = USD 3000/kW
- Biomass input – NAD600/t

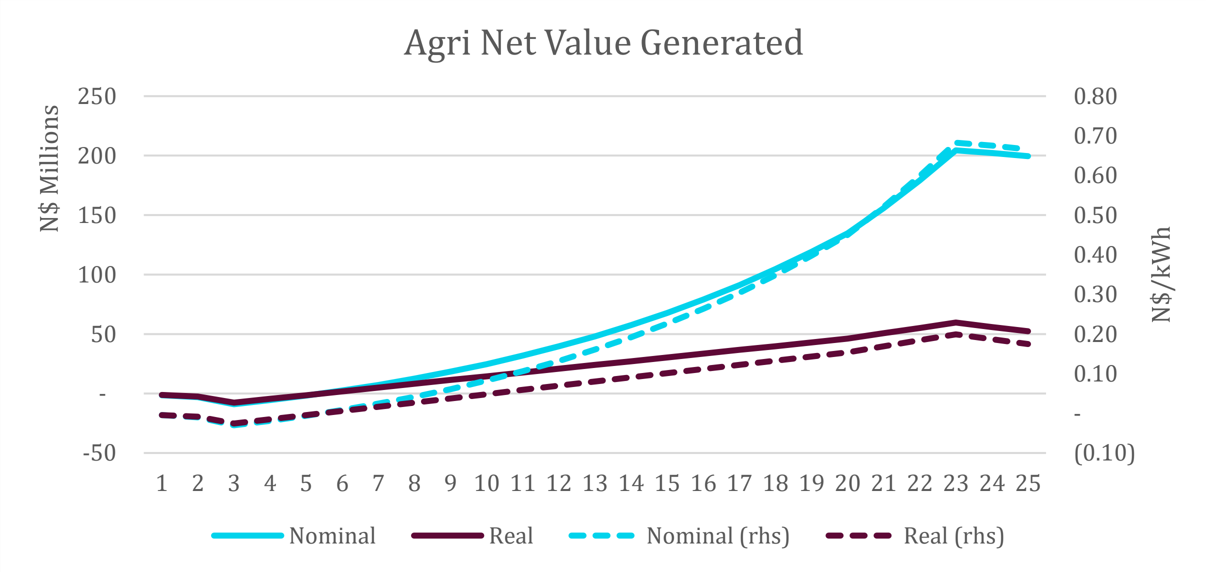


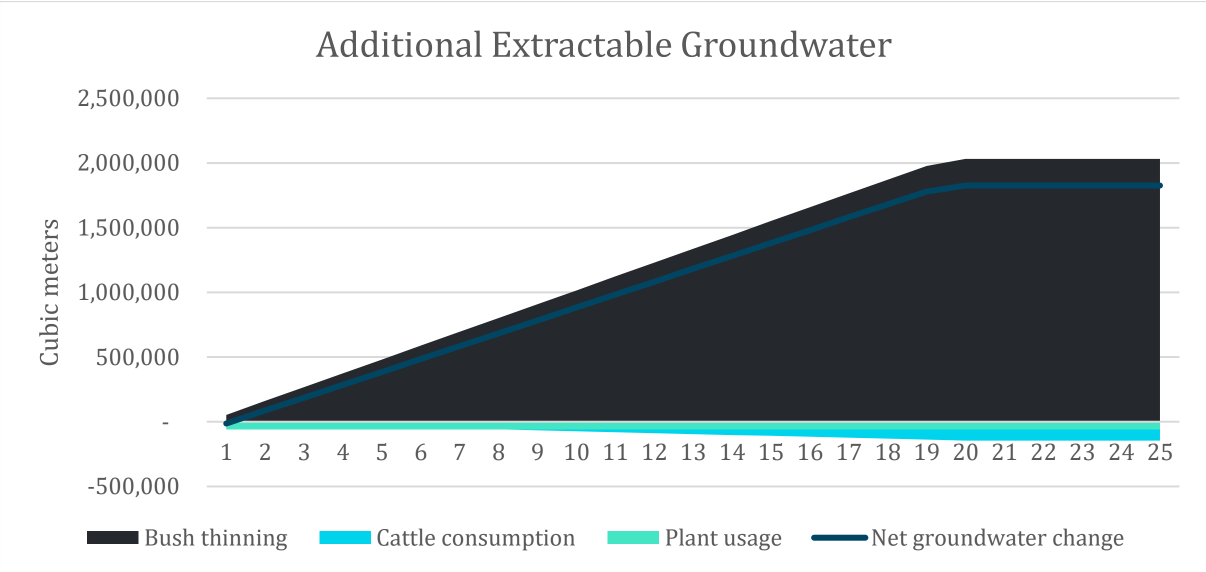


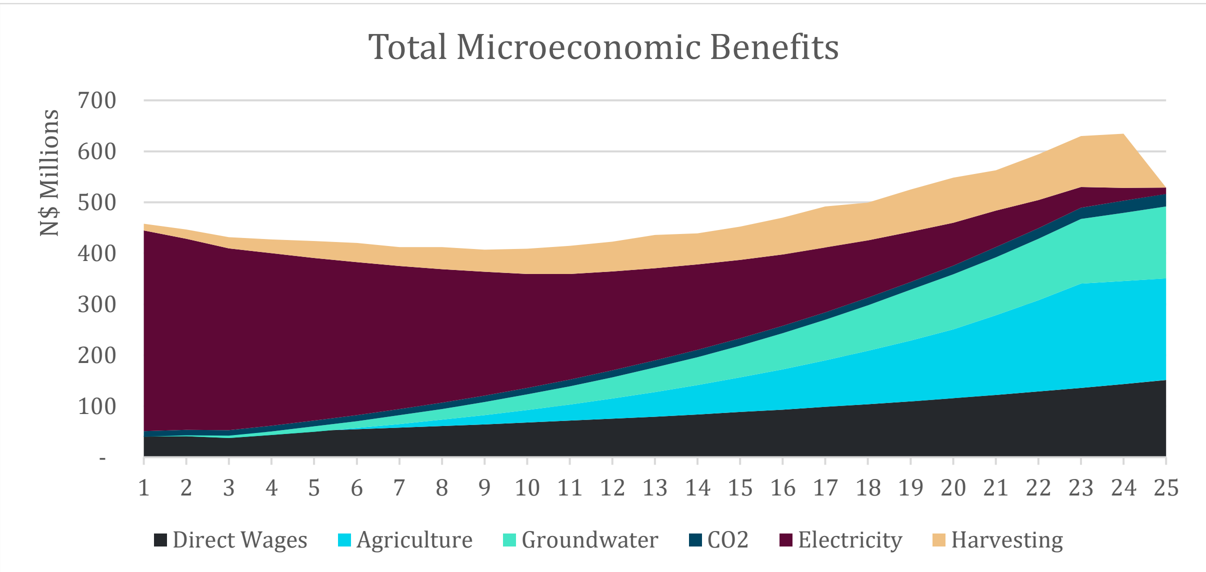

Direct Wages (nominal)
N$ Millions
N$/kWh
120
100
80
60
40
20
-
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
Harvester
Power Plant

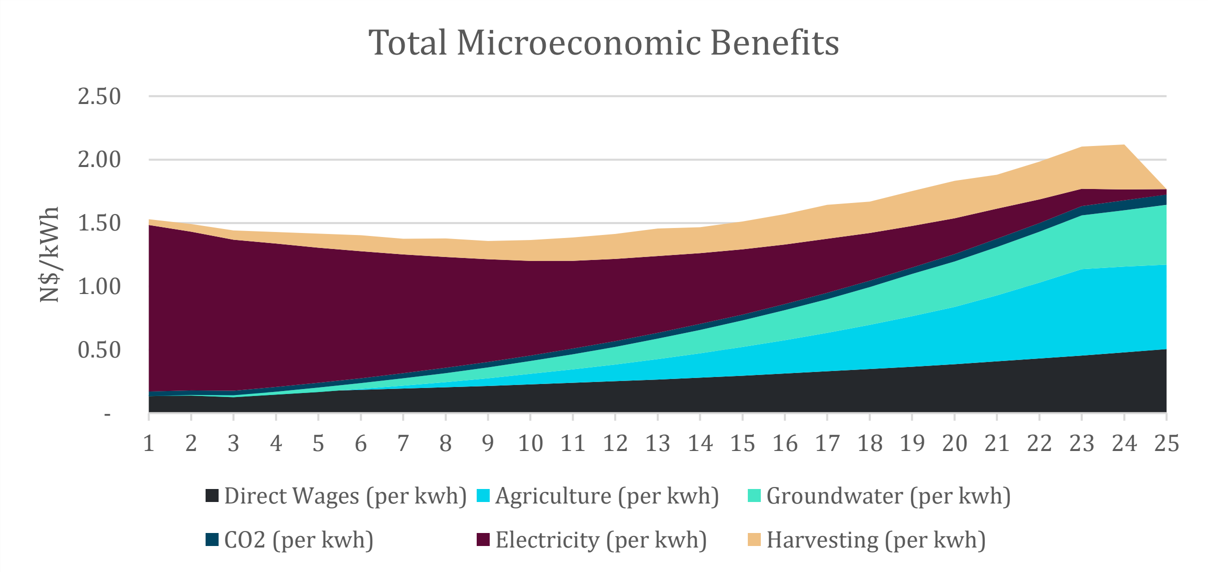

Cattle Farming Land (ha)
3,500,000
3,000,000
2,500,000
2,000,000
1,500,000
1,000,000
500,000
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
Encroached
Thinned

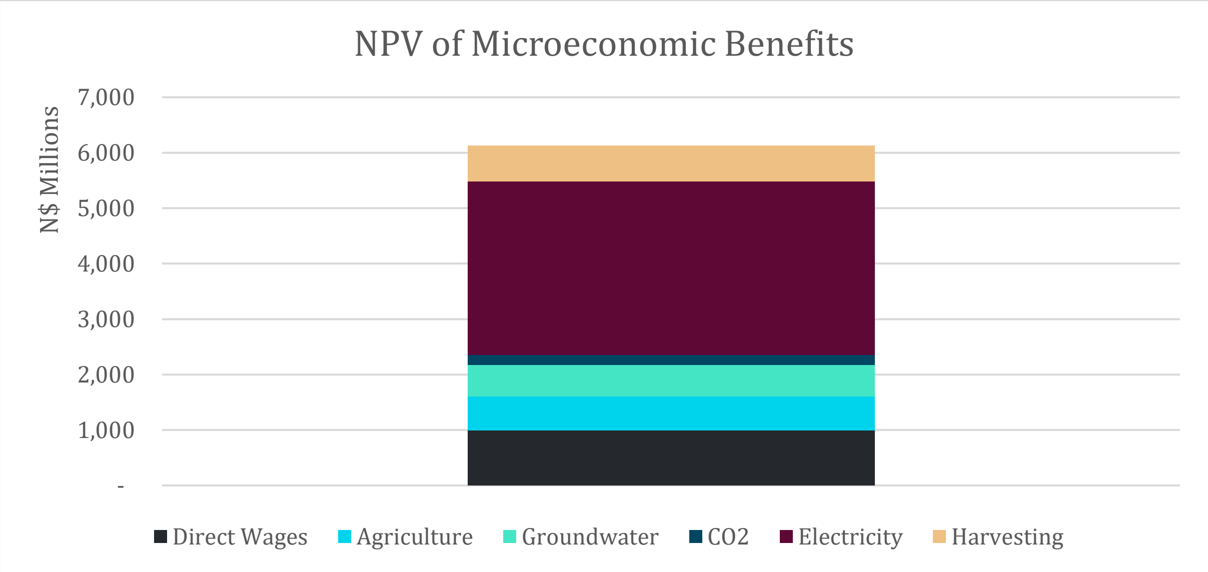

Heads of Cattle
205,000
200,000
195,000
190,000
185,000
180,000
175,000
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
Cattle BAU
After thinning

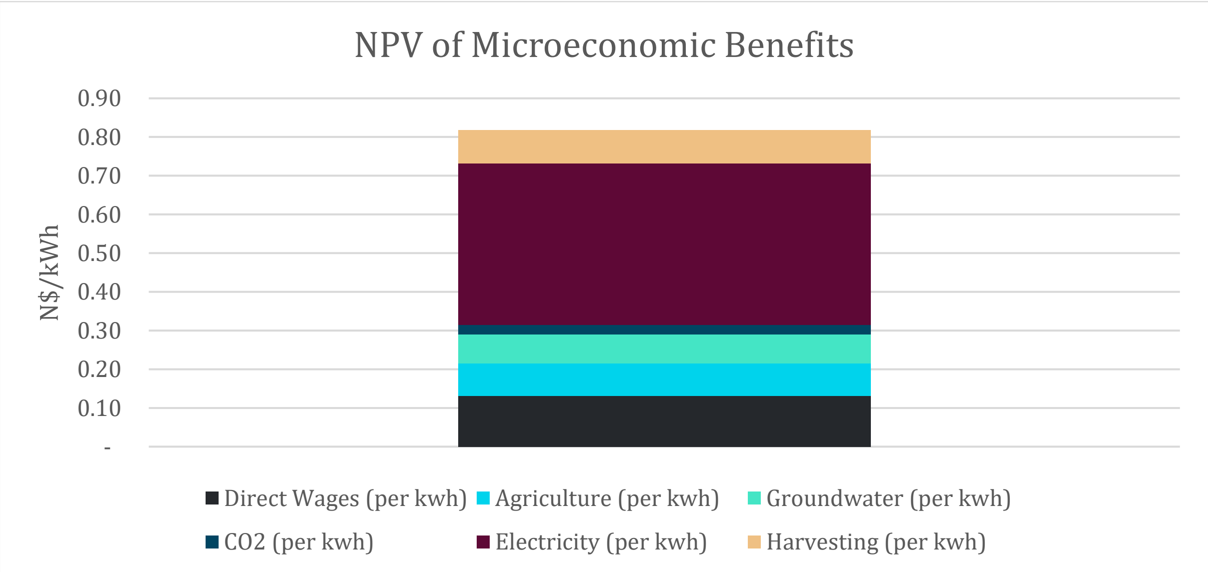

Agri Net Value Generated
N$ Millions
250
200
150
100
50
-
-50
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
-
(0.10)
N$/kWh
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
Nominal
Real
Nominal (rhs)
Real (rhs)

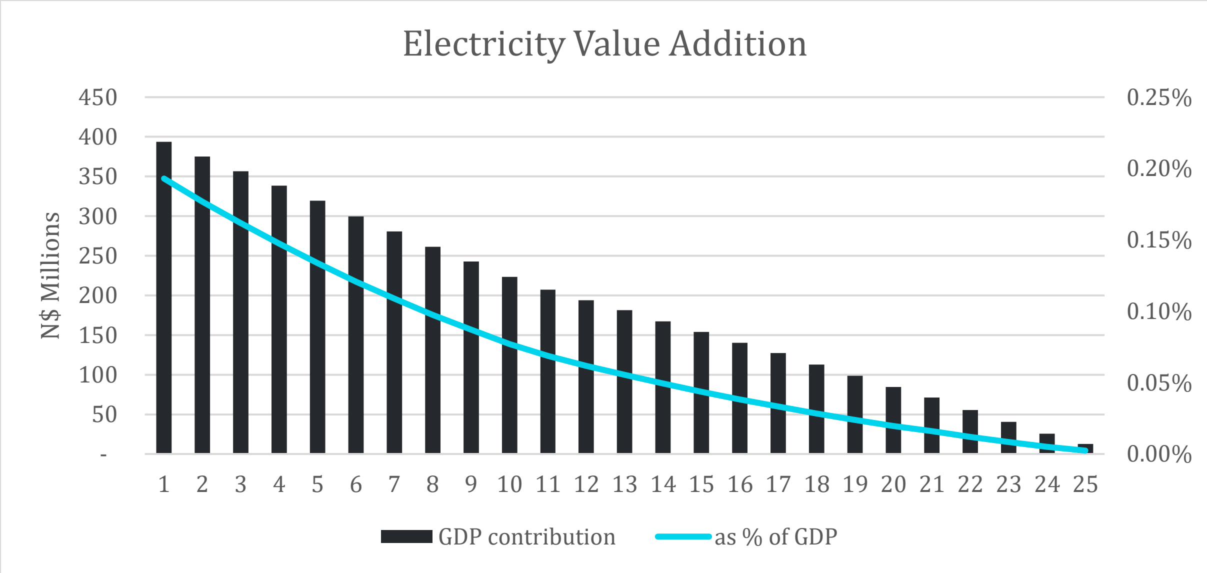

Additional Extractable Groundwater
Cubic meters
2,500,000
2,000,000
1,500,000
1,000,000
500,000
-
-500,000
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
Bush thinning
Cattle consumption
Plant usage
Net groundwater change

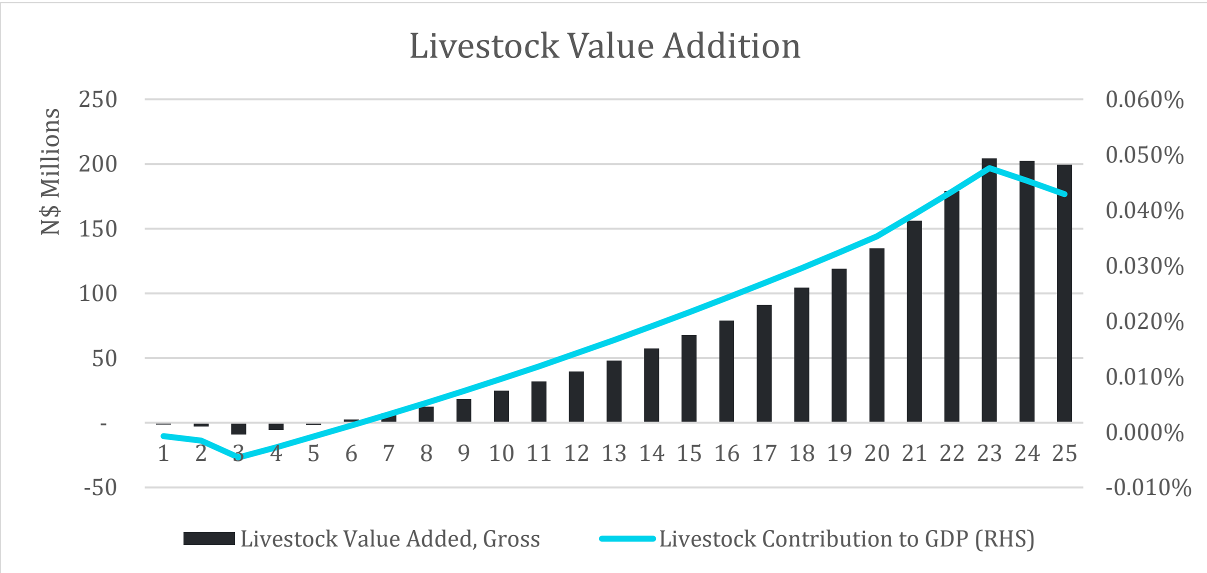

Total Microeconomic Benefits
N$ Millions
700
600
500
400
300
200
100
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
Direct Wages
Agriculture
Groundwater
CO2
Electricity
Harvesting

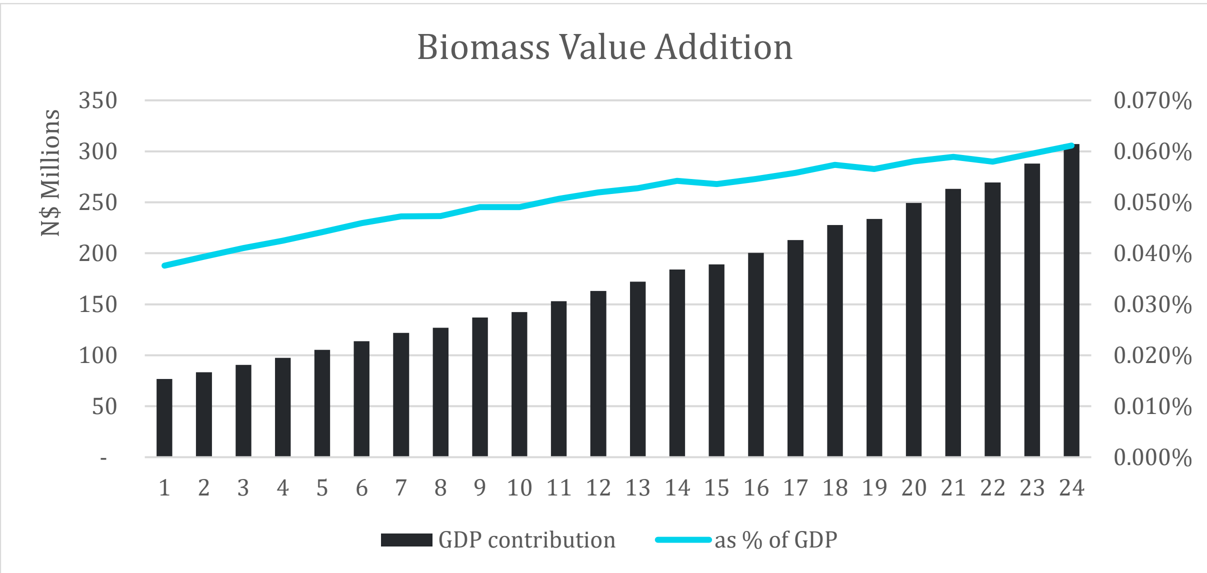

Total Microeconomic Benefits
2.50
2.00
1.50
1.00
0.50
-
N$/kWh
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
Direct Wages (per kwh)
Agriculture (per kwh)
Groundwater (per kwh)
CO2 (per kwh)
Electricity (per kwh)
Harvesting (per kwh)

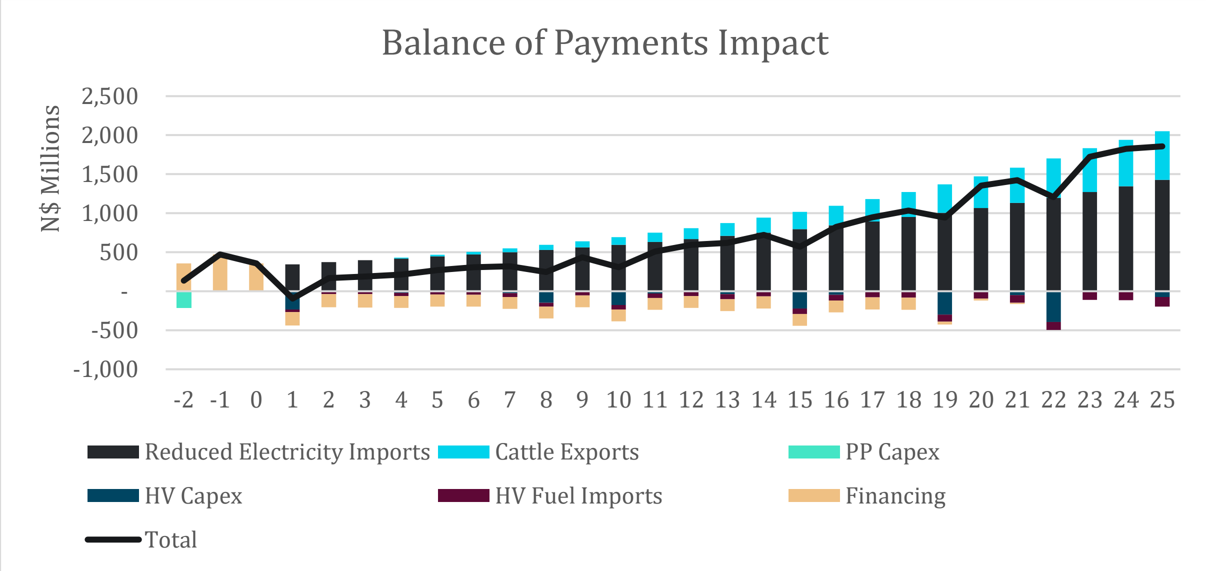

NPV of Microeconomic Benefits
7,000
6,000
5,000
4,000
3,000
2,000
1,000
-
N$ Millions
Direct Wages
Agriculture
Groundwater
CO2
Electricity
Harvesting


NPV of Microeconomic Benefits
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
-
N$/kWh
Direct Wages (per kwh)
Agriculture (per kwh)
Groundwater (per kwh)
CO2 (per kwh)
Electricity (per kwh)
Harvesting (per kwh)

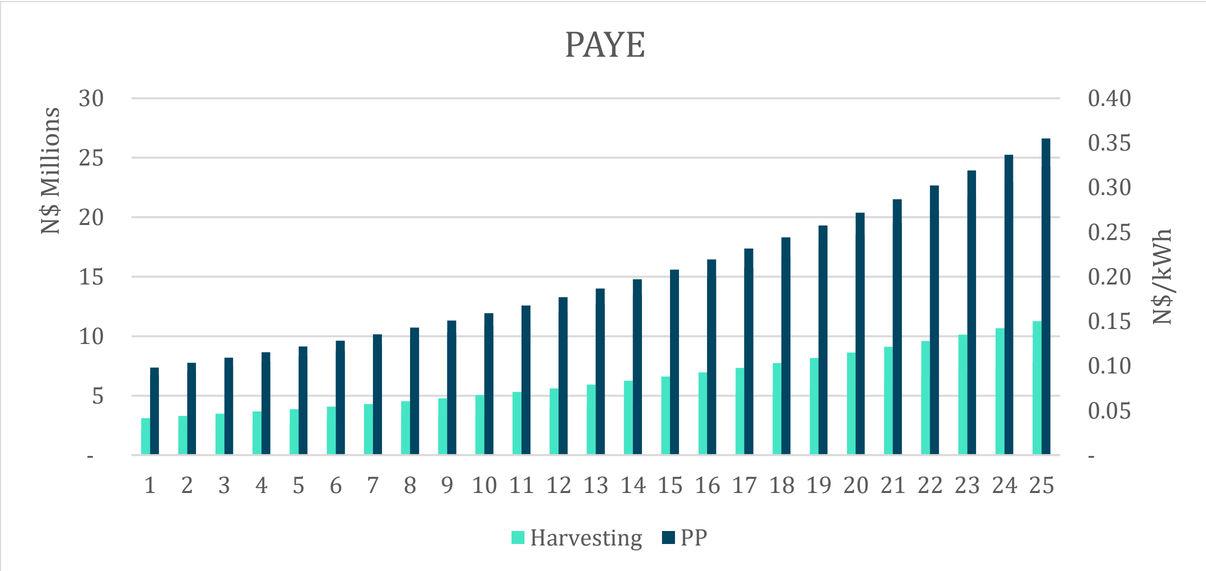

Electricity Value Addition
N$ Millions
450
400
350
300
250
200
150
100
50
-
0.25%
0.20%
0.15%
0.10%
0.05%
0.00%
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
GDP contribution
as % of GDP


Livestock Value Addition
N$ Millions
250
200
150
100
50
-
-50
0.060%
0.050%
0.040%
0.030%
0.020%
0.010%
0.000%
-0.010%
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
Livestock Value Added, Gross
Livestock Contribution to GDP (RHS)

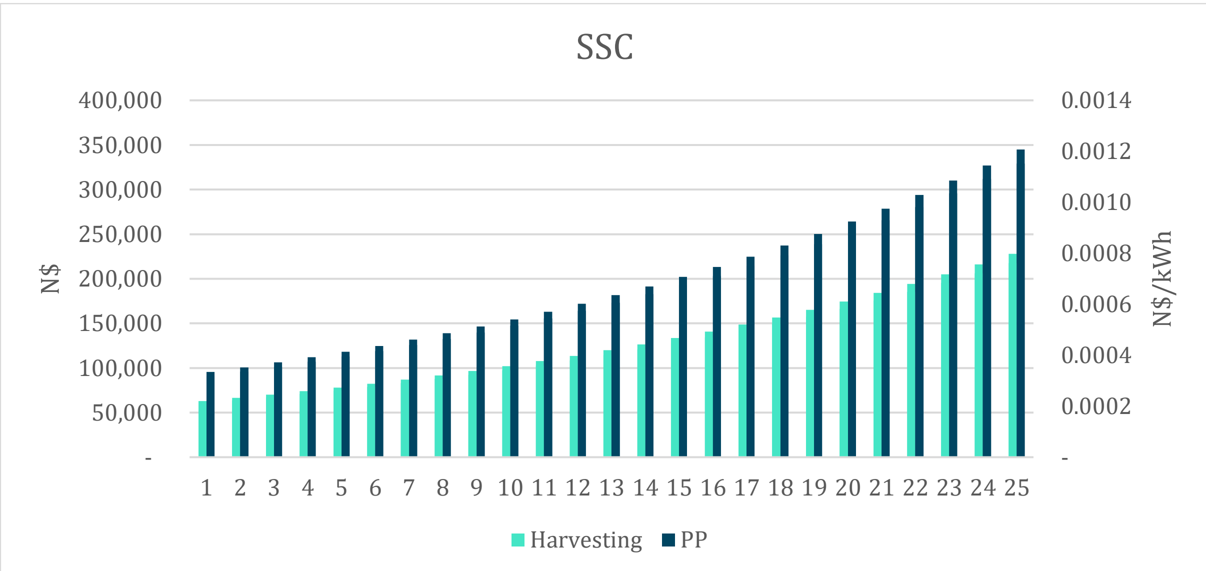

Biomass Value Addition
N$ Millions
350
300
250
200
150
100
50
-
0.070%
0.060%
0.050%
0.040%
0.030%
0.020%
0.010%
0.000%
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
GDP contribution
as % of GDP



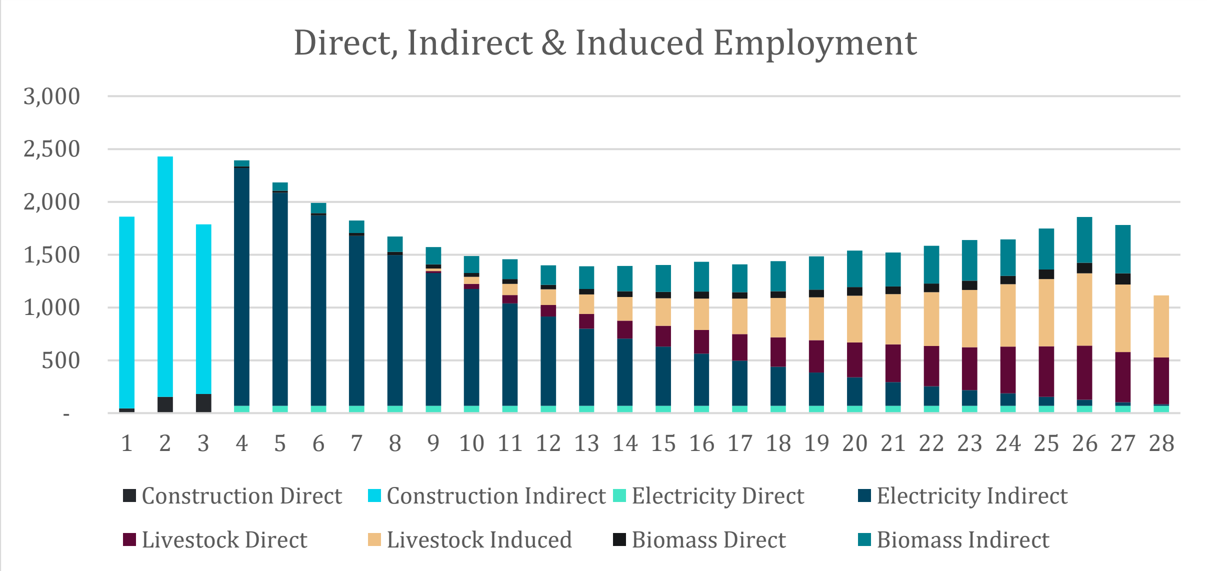
Balance of Payments Impact
N$ Millions
2,500
2,000
1,500
1,000
500
-
-500
-1,000
-2 -1 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
Reduced Electricity Imports
Cattle Exports
PP Capex
HV Capex
HV Fuel Imports
Financing
Total

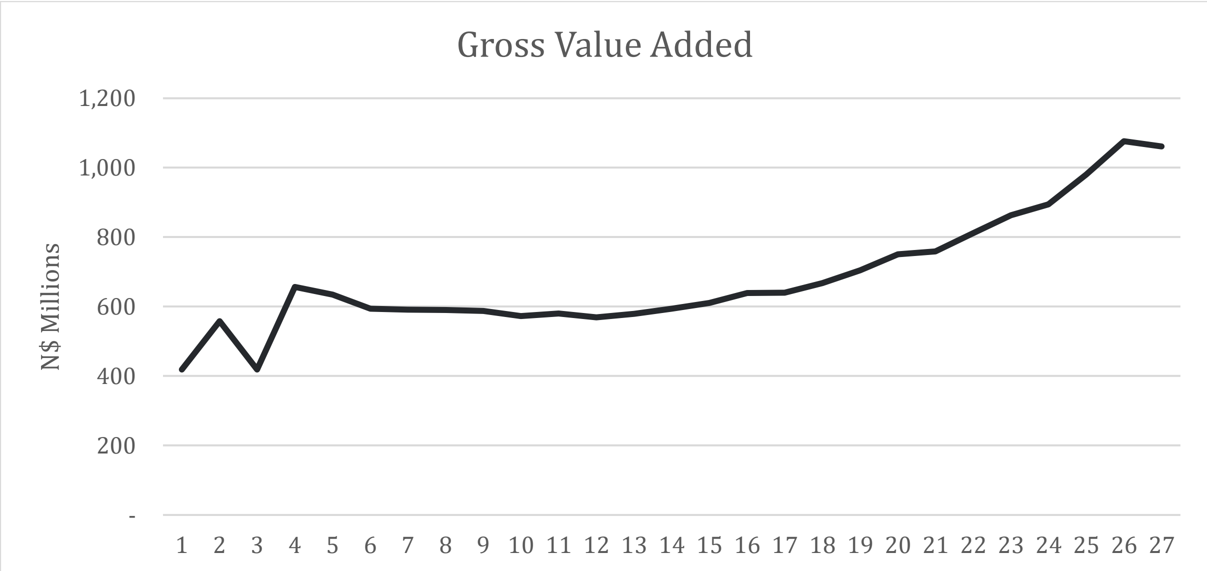


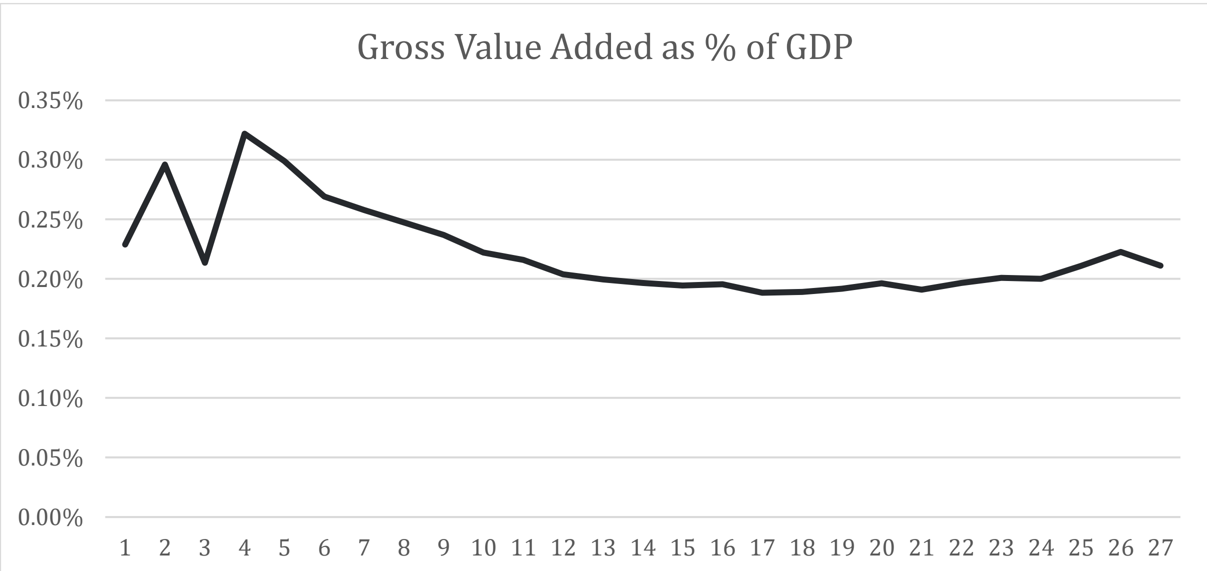
PAYE
N$ Millions
30
25
20
15
10
5
-
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
-
N$/kWh
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
Harvesting
PP

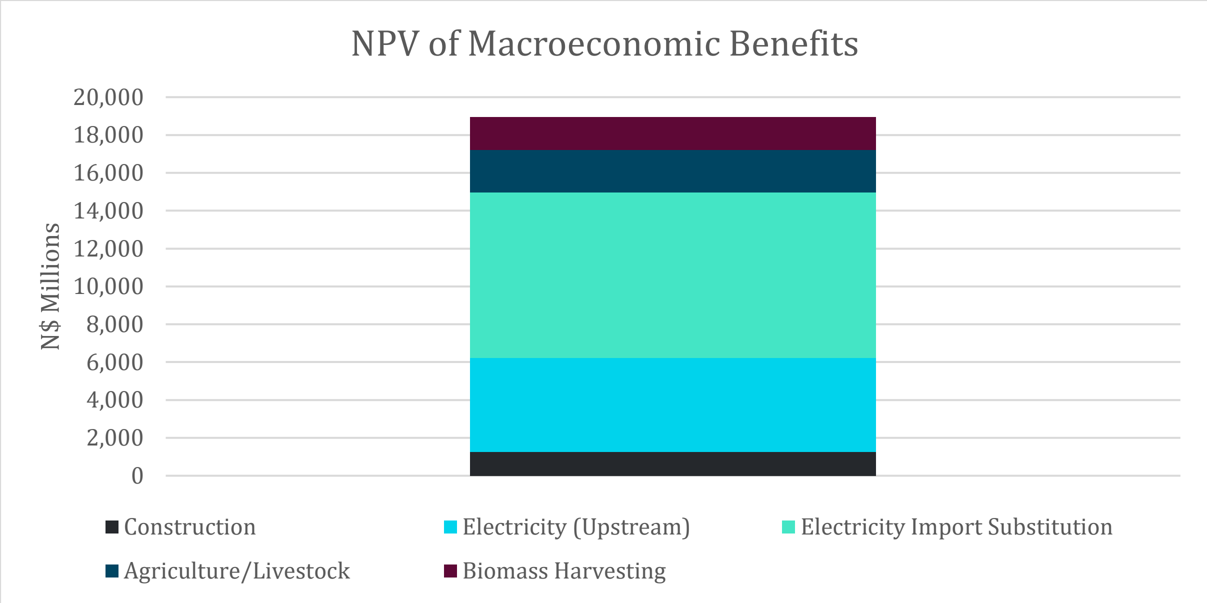


SSC
N$
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
-
0.0014
0.0012
0.0010
0.0008
0.0006
0.0004
0.0002
-
N$/kWh
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
Harvesting
PP

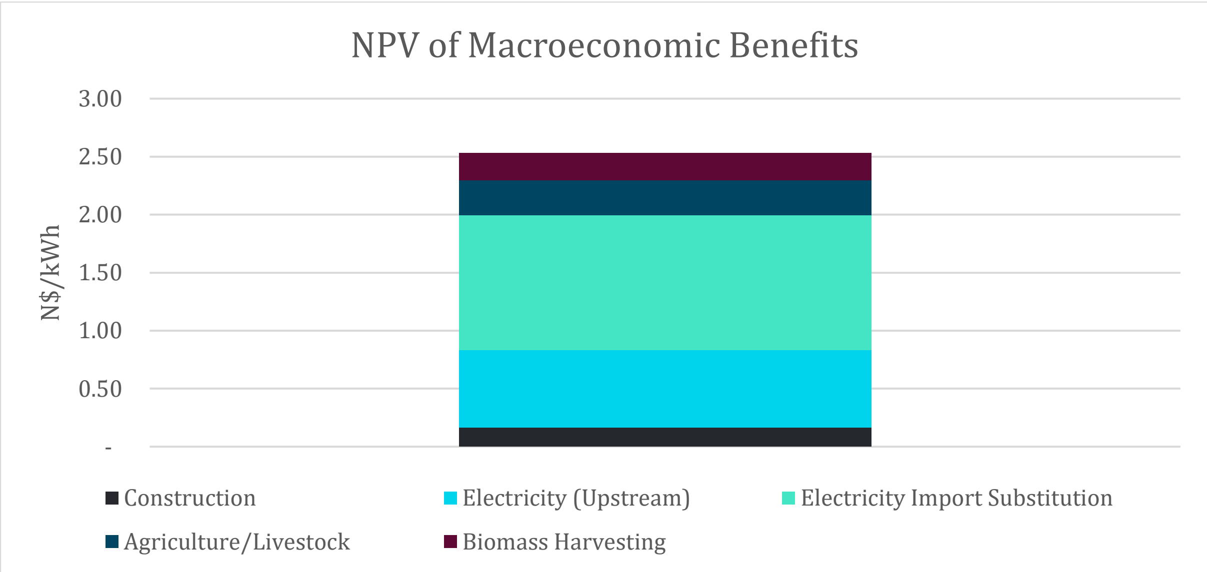

Direct, Indirect & Induced Employment
3,000
2,500
2,000
1,500
1,000
500
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28
Construction Direct
Construction Indirect
Electricity Direct
Electricity Indirect
Livestock Direct
Livestock Induced
Biomass Direct
Biomass Indirect


Gross Value Added
N$ Millions
1,200
1,000
800
600
400
200
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27


Gross Value Added as % of GDP
0.35%
0.30%
0.25%
0.20%
0.15%
0.10%
0.05%
0.00%
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27



NPV of Macroeconomic Benefits
N$ Millions
20,000
18,000
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
Construction
Electricity (Upstream)
Electricity Import Substitution
Agriculture/Livestock
Biomass Harvesting

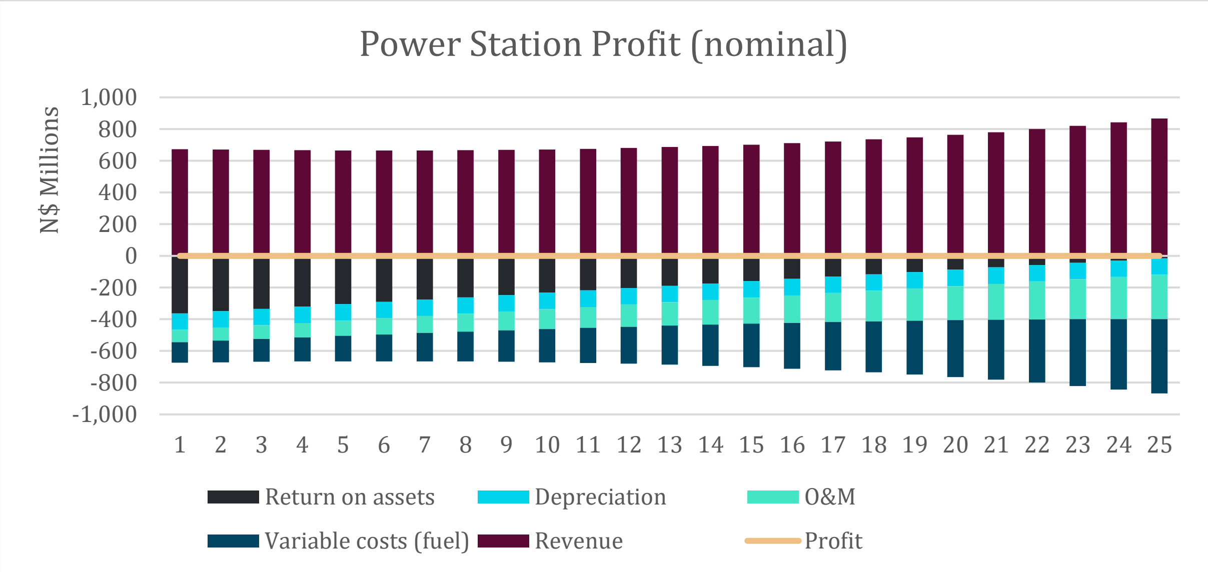


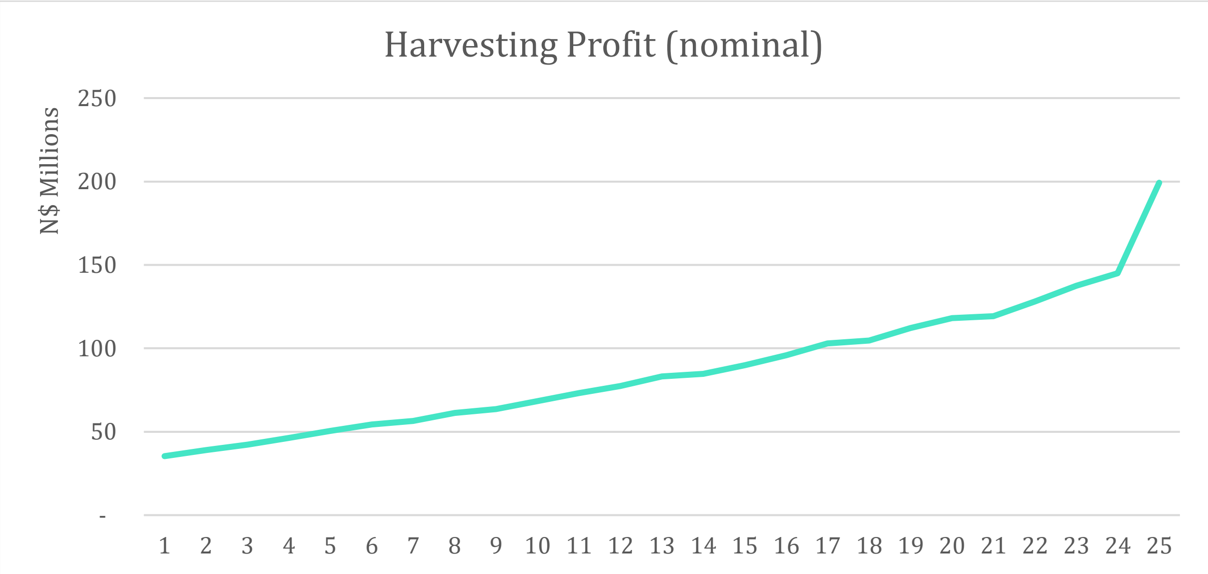
NPV of Macroeconomic Benefits
N$/kWh
3.00
2.50
2.00
1.50
1.00
0.50
-
Construction
Electricity (Upstream)
Electricity Import Substitution
Agriculture/Livestock
Biomass Harvesting

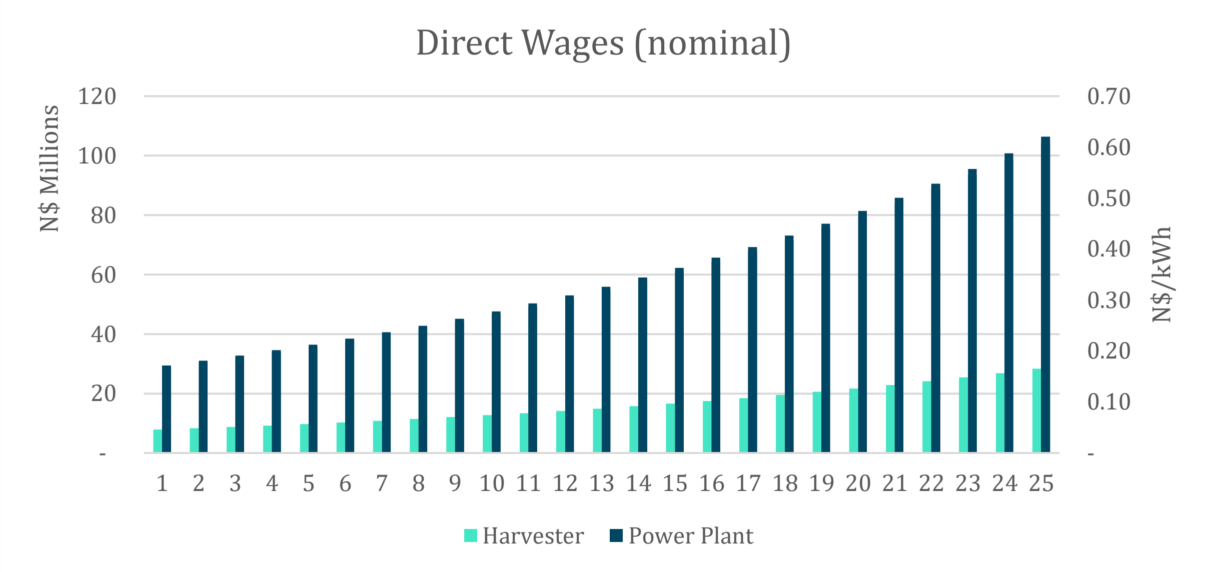
Appendix 6

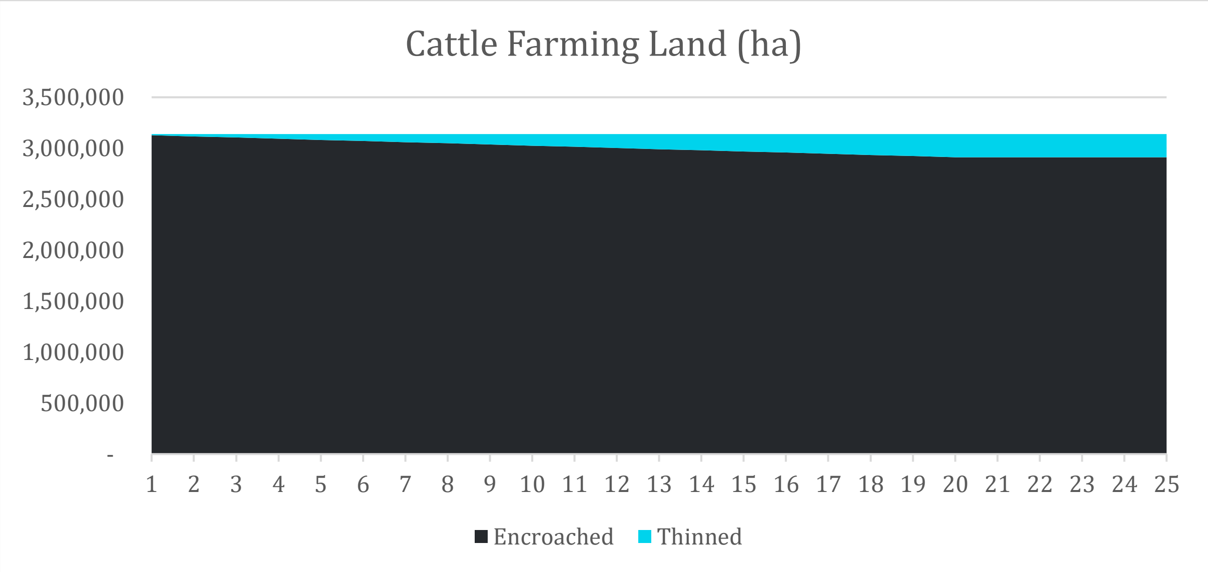
'Worst Case' Scenario:

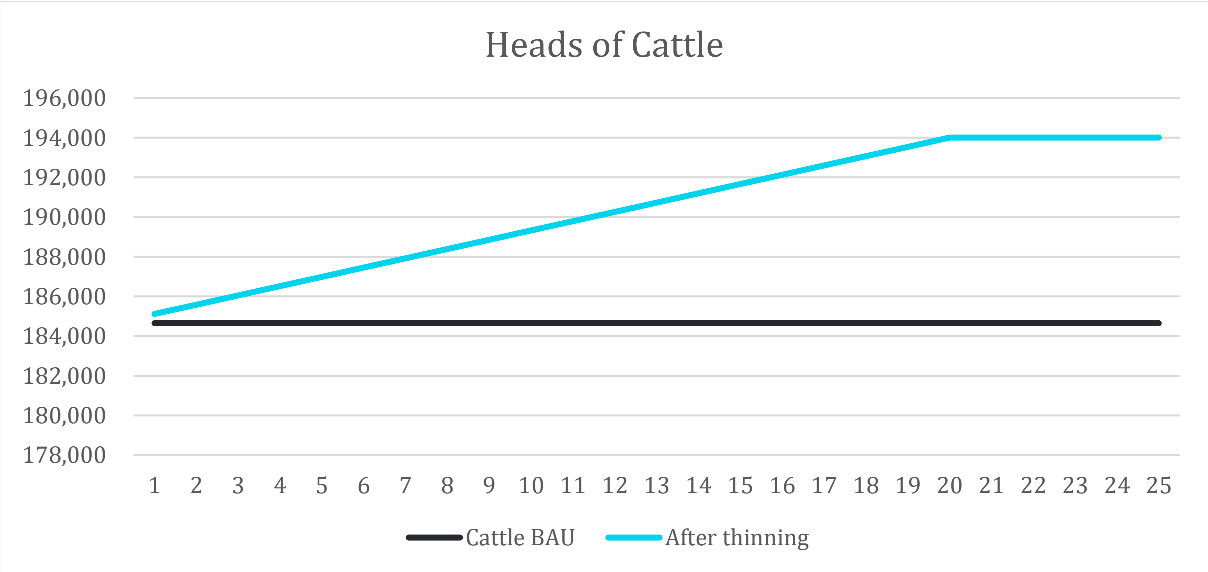
- Power station = 40MWe
- Capacity Factor = 50%
- Price per kWh installed = USD 4000/kW
- Biomass input – NAD900/t

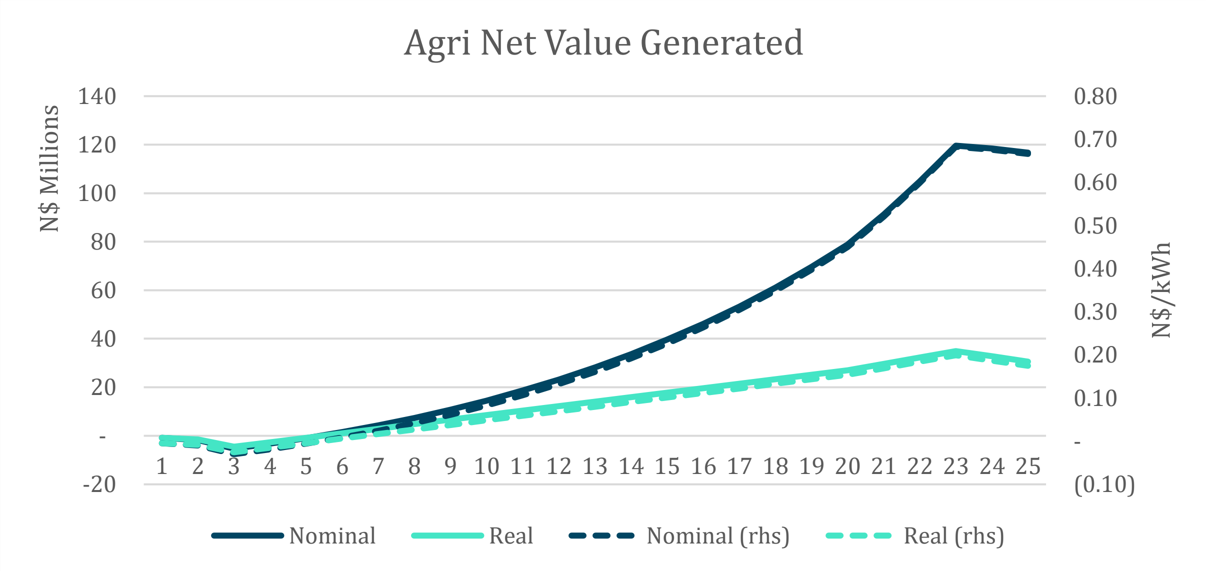


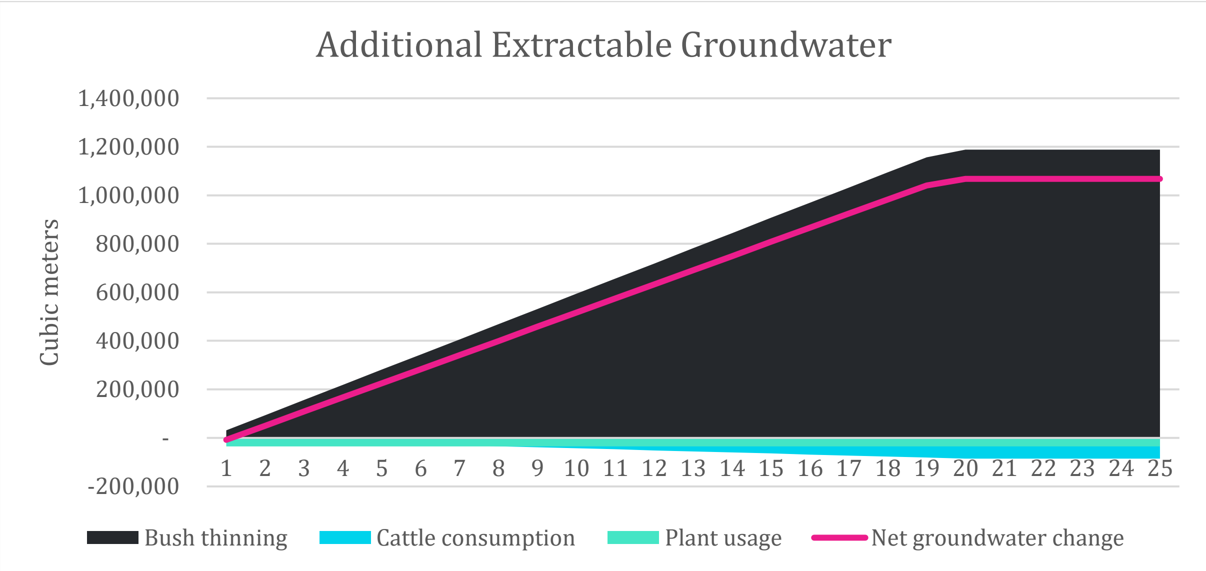


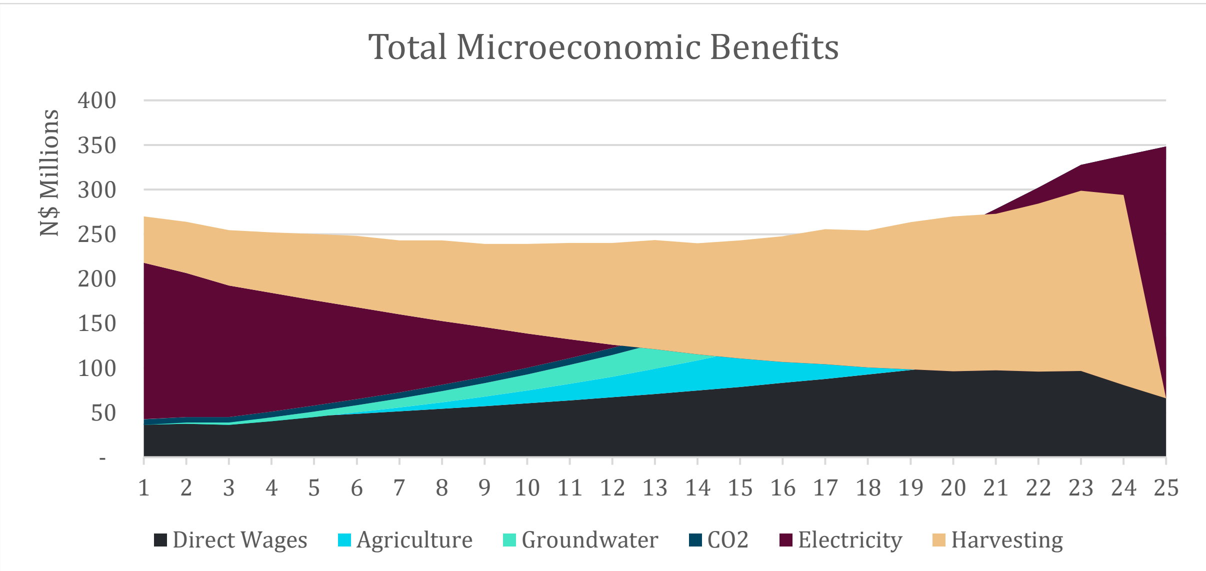

Direct Wages (nominal)
N$ Millions
120
100
80
60
40
20
-
0.70
0.60
0.50
0.40
0.30
0.20
0.10
-
N$/kWh
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
Harvester
Power Plant

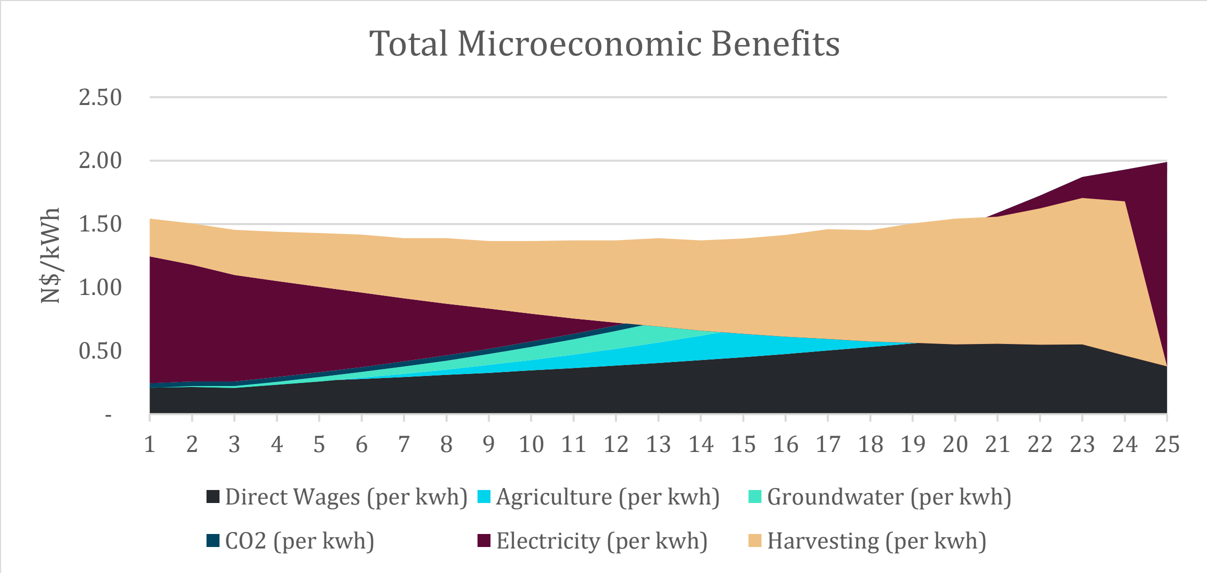

Cattle Farming Land (ha)
3,500,000
3,000,000
2,500,000
2,000,000
1,500,000
1,000,000
500,000
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
Encroached
Thinned

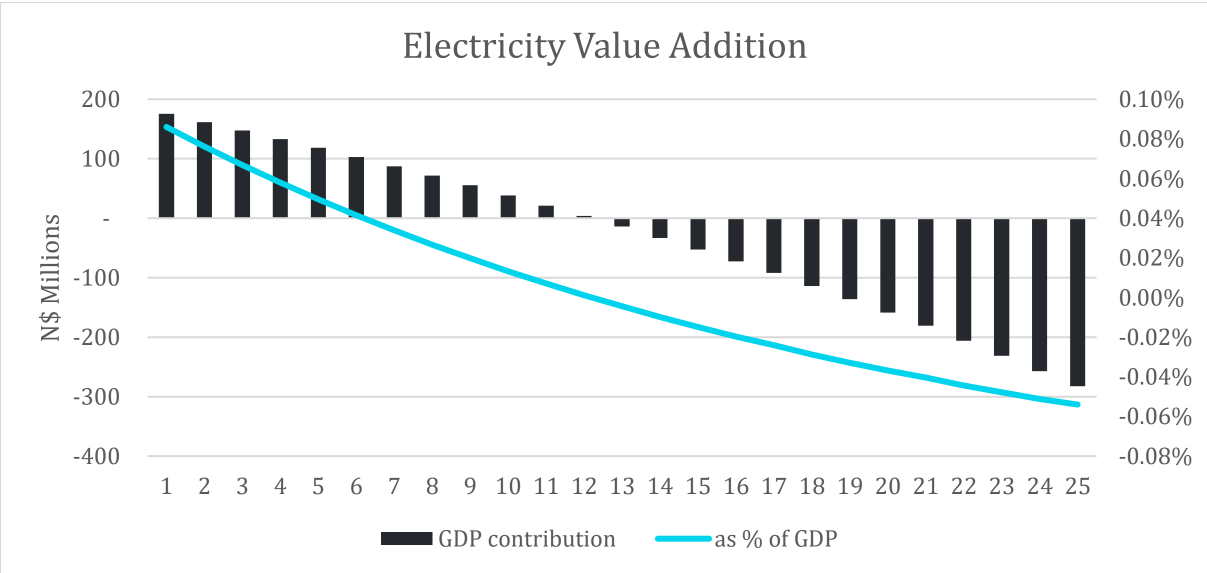

Heads of Cattle
196,000
194,000
192,000
190,000
188,000
186,000
184,000
182,000
180,000
178,000
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
Cattle BAU
After thinning

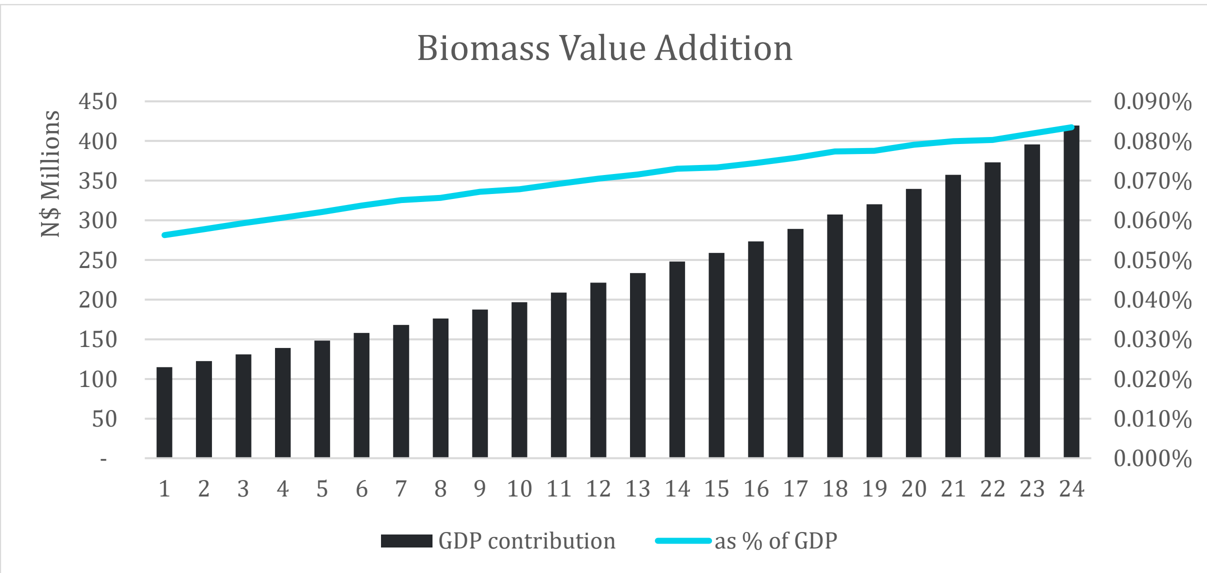

Agri Net Value Generated
N$ Millions
N$/kWh
140
120
100
80
60
40
20
-
-20
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
-
(0.10)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
Nominal
Real
Nominal (rhs)
Real (rhs)

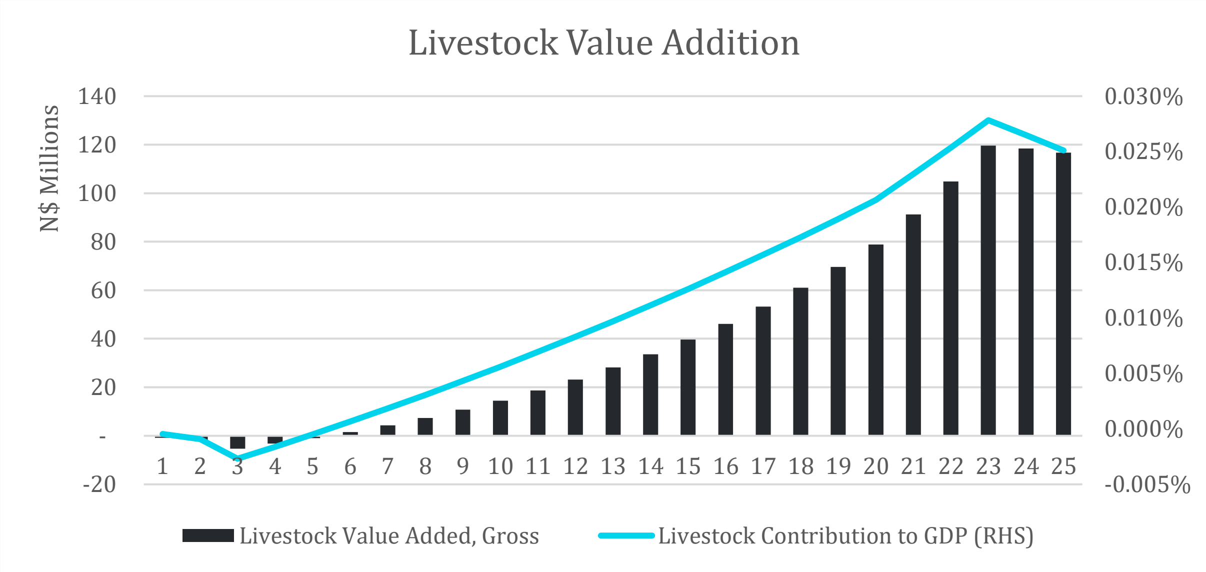

Additional Extractable Groundwater
Cubic meters
1,400,000
1,200,000
1,000,000
800,000
600,000
400,000
200,000
-
-200,000
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
Bush thinning
Cattle consumption
Plant usage
Net groundwater change

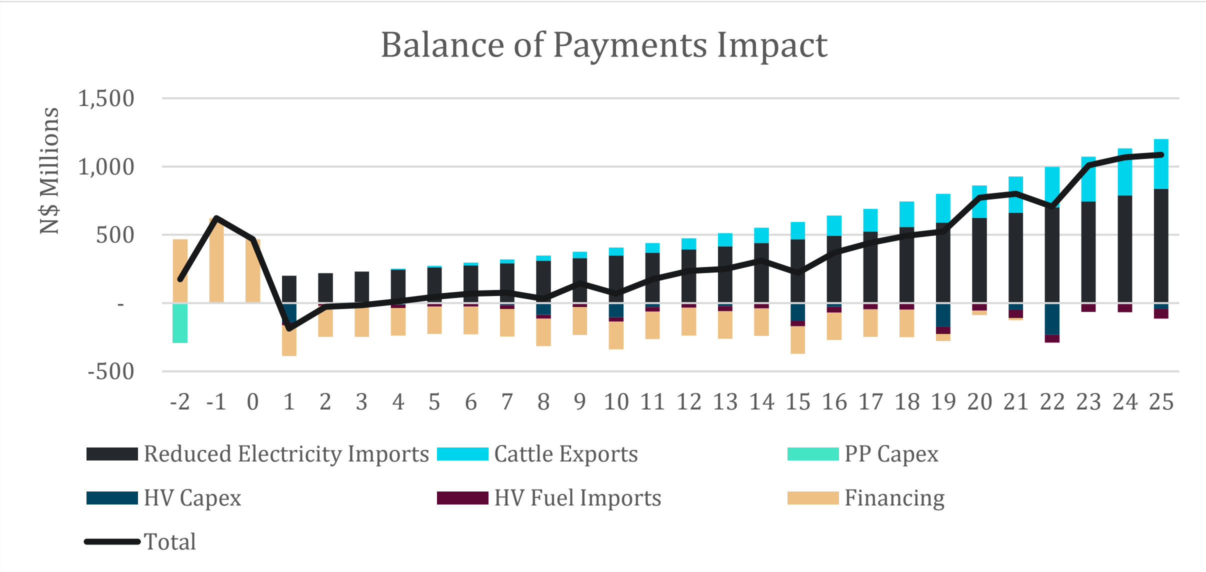

Total Microeconomic Benefits
N$ Millions
400
350
300
250
200
150
100
50
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
Direct Wages
Agriculture
Groundwater
CO2
Electricity
Harvesting

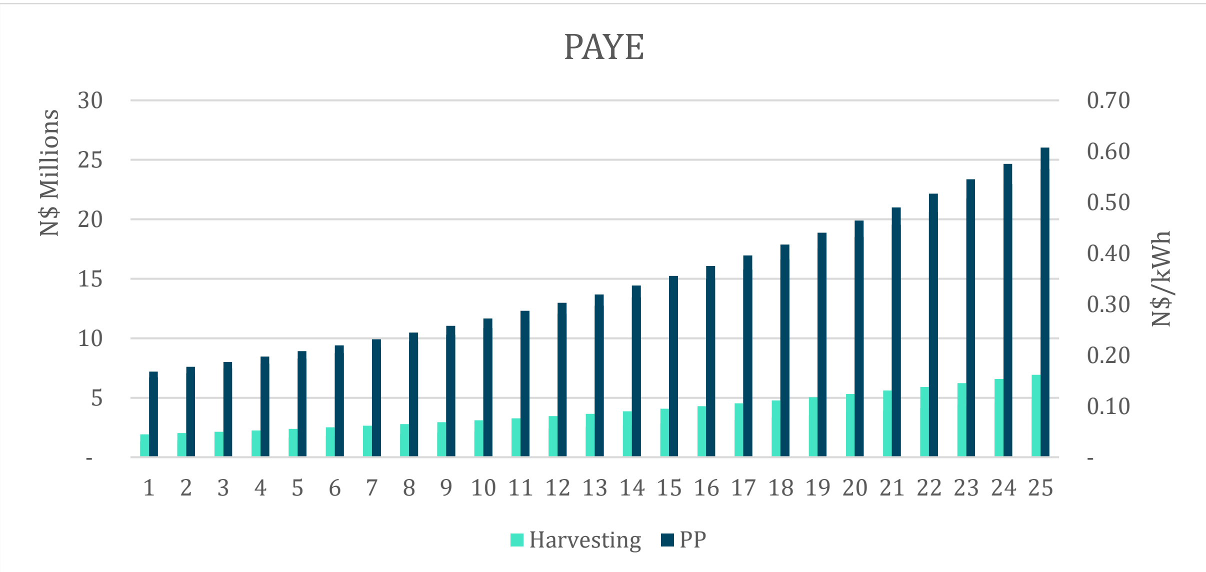

Total Microeconomic Benefits
2.50
2.00
1.50
1.00
0.50
-
N$/kWh
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
Direct Wages (per kwh)
Agriculture (per kwh)
Groundwater (per kwh)
CO2 (per kwh)
Electricity (per kwh)
Harvesting (per kwh)

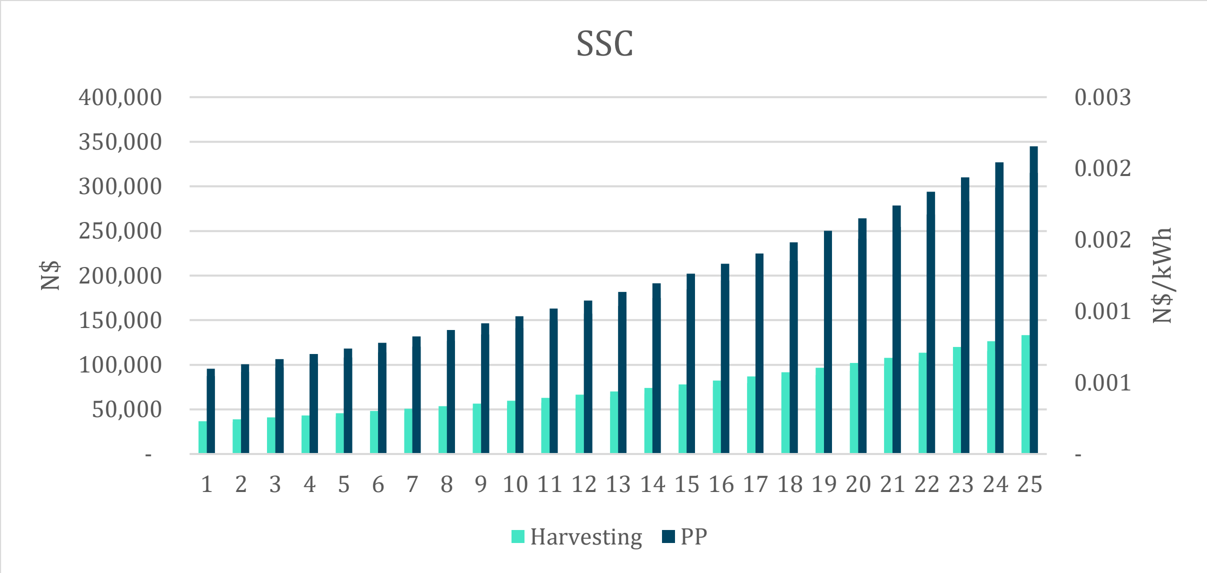

Electricity Value Addition
200
100
-
-100
-200
-300
-400
N$ Millions
0.10%
0.08%
0.06%
0.04%
0.02%
0.00%
-0.02%
-0.04%
-0.06%
-0.08%
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
GDP contribution
as % of GDP

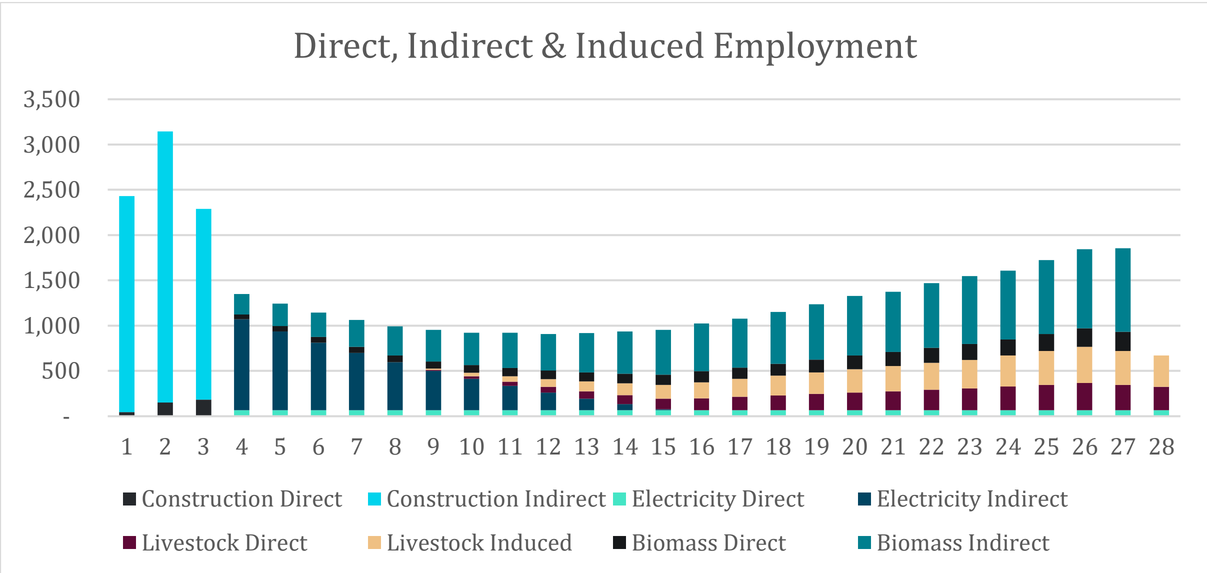

Biomass Value Addition
450
400
350
300
250
200
150
100
50
-
N$ Millions
0.090%
0.080%
0.070%
0.060%
0.050%
0.040%
0.030%
0.020%
0.010%
0.000%
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
GDP contribution
as % of GDP

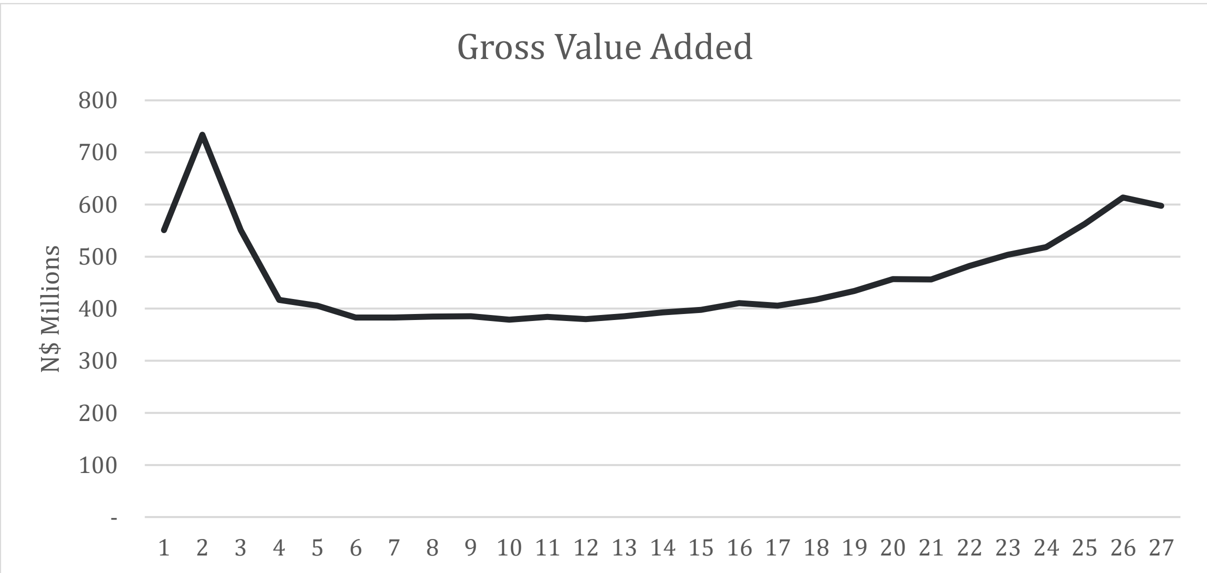

Livestock Value Addition
N$ Millions
140
120
100
80
60
40
20
-
-20
0.030%
0.025%
0.020%
0.015%
0.010%
0.005%
0.000%
-0.005%
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
Livestock Value Added, Gross
Livestock Contribution to GDP (RHS)

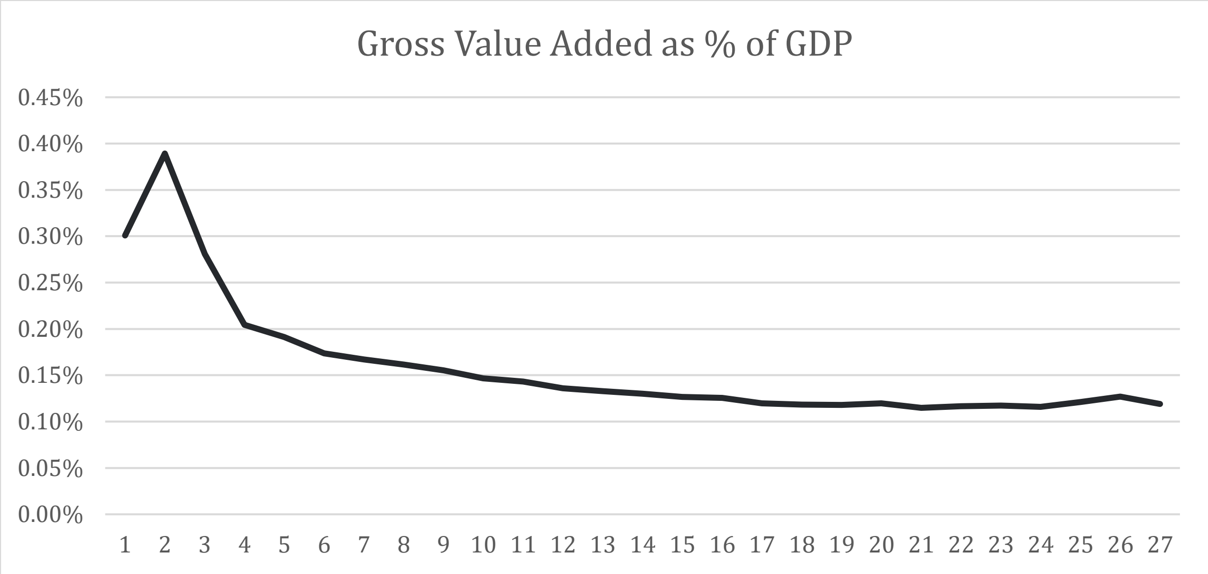

Balance of Payments Impact
N$ Millions
1,500
1,000
500
-
-500
-2 -1 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
Reduced Electricity Imports
Cattle Exports
PP Capex
HV Capex
HV Fuel Imports
Financing
Total

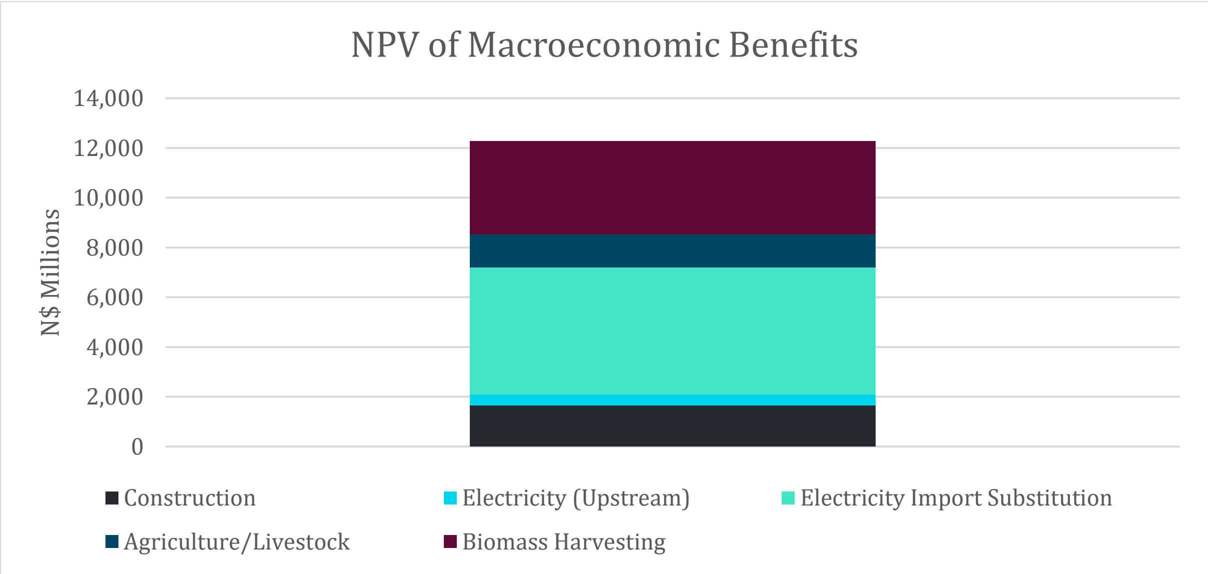

PAYE
N$ Millions
30
25
20
15
10
5
-
0.70
0.60
0.50
0.40
0.30
0.20
0.10
-
N$/kWh
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
Harvesting
PP

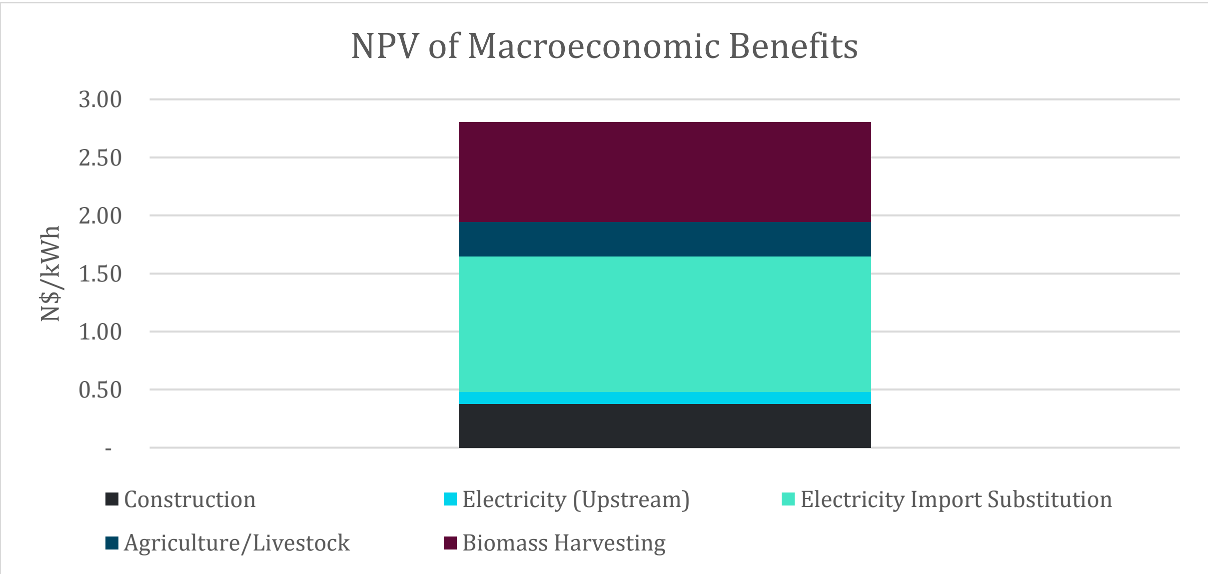

SSC
N$
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
-
N$/kWh
0.003
0.002
0.002
0.001
0.001
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
Harvesting
PP


Direct, Indirect & Induced Employment
3,500
3,000
2,500
2,000
1,500
1,000
500
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28
Construction Direct
Construction Indirect
Electricity Direct
Electricity Indirect
Livestock Direct
Livestock Induced
Biomass Direct
Biomass Indirect


Gross Value Added
N$ Millions
800
700
600
500
400
300
200
100
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27


Gross Value Added as % of GDP
0.45%
0.40%
0.35%
0.30%
0.25%
0.20%
0.15%
0.10%
0.05%
0.00%
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27

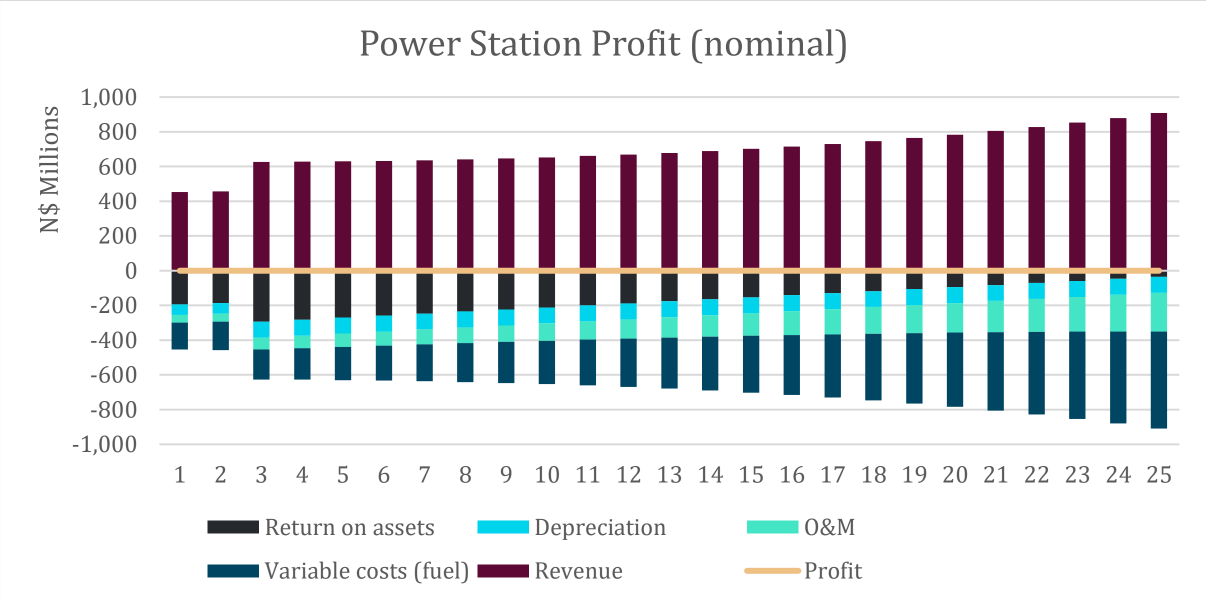

NPV of Macroeconomic Benefits
N$ Millions
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
Construction
Electricity (Upstream)
Electricity Import Substitution
Agriculture/Livestock
Biomass Harvesting


NPV of Macroeconomic Benefits
N$/kWh
3.00
2.50
2.00
1.50
1.00
0.50
-
Construction
Electricity (Upstream)
Electricity Import Substitution
Agriculture/Livestock
Biomass Harvesting

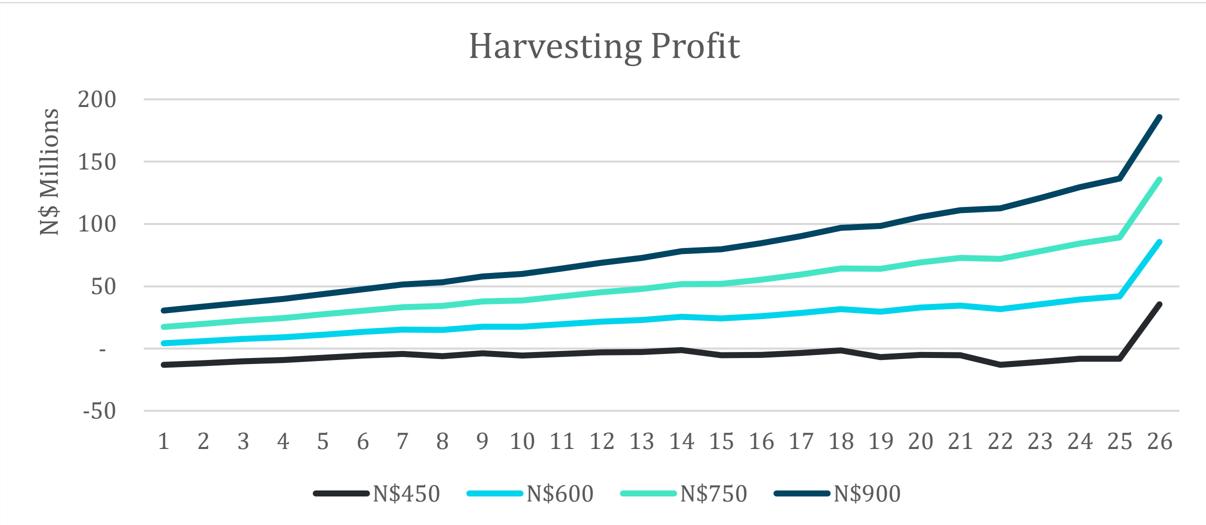
Appendix 7

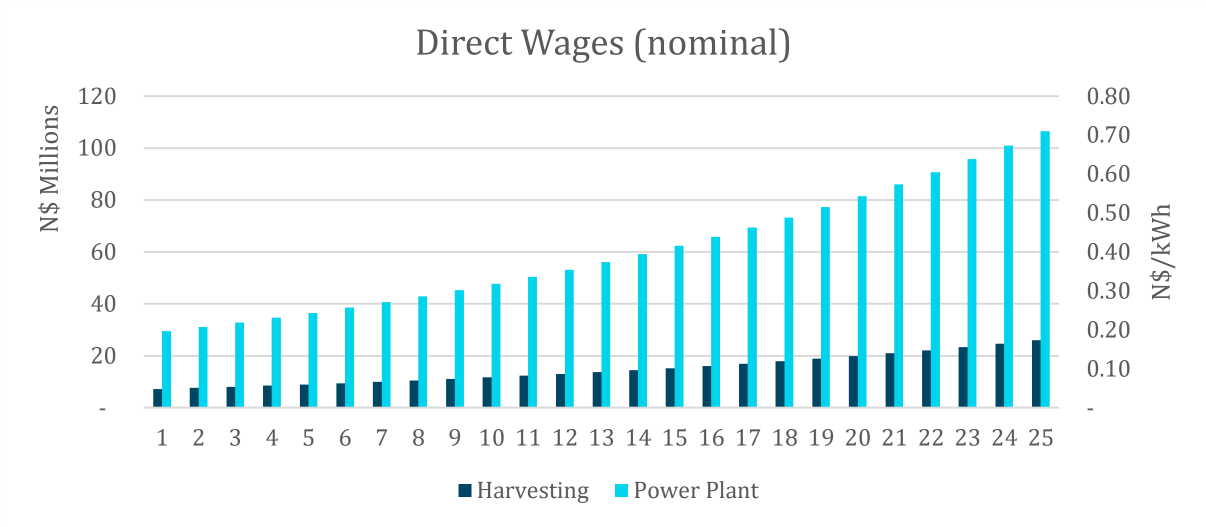
Scenario:

- Power station = 2 x 20MWe
- Capacity Factor = 85%
- Price per kWh installed = USD 3500/kW

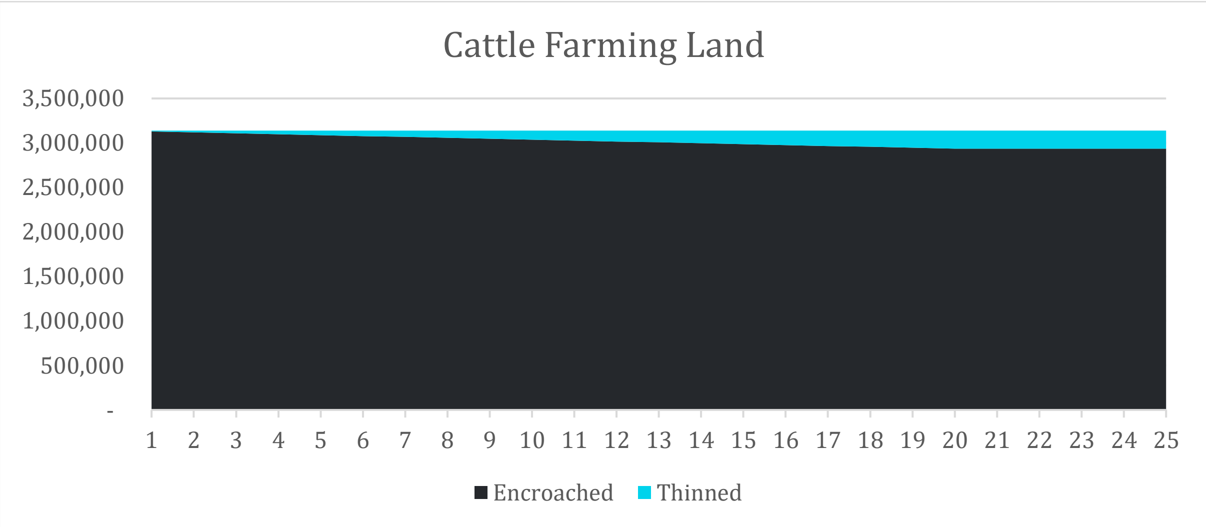


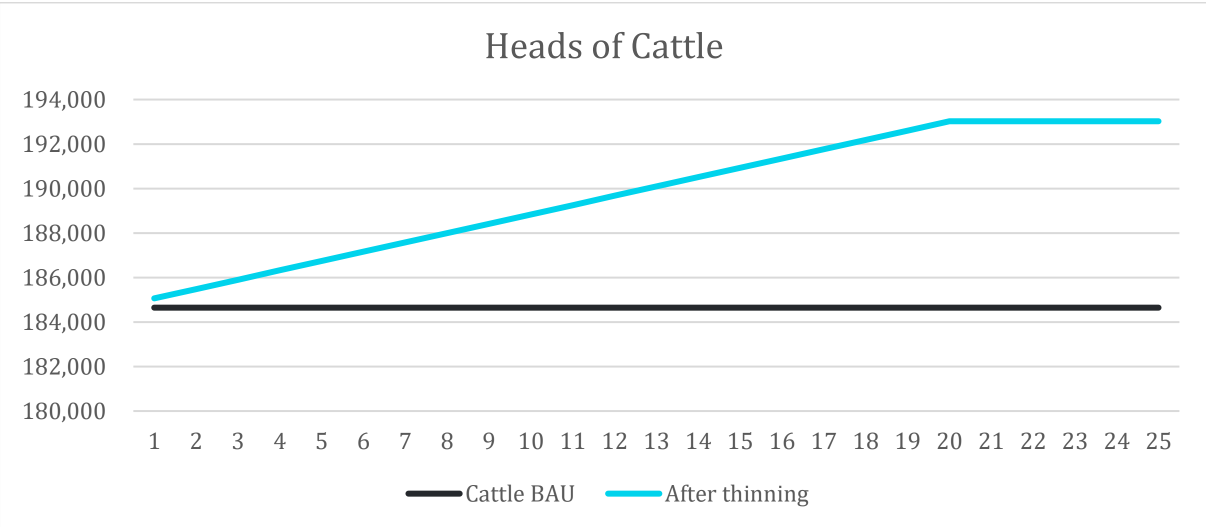
The harvesters, on the other hand, similarly run into profits continuously for all price points except NAD450/t.



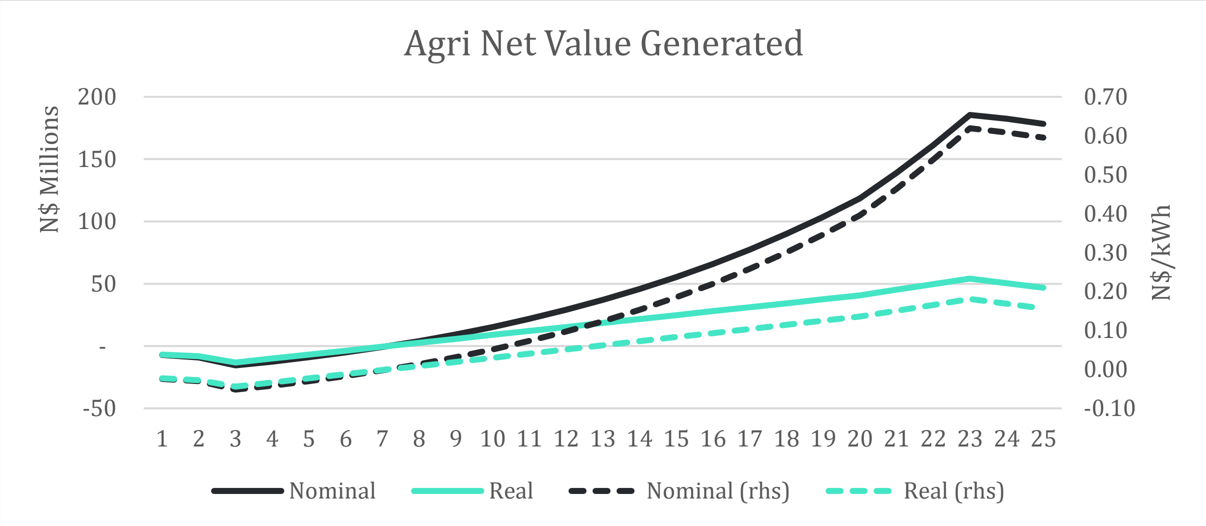


Each power station has an annual fuel requirement of 128,687.43t of biomass, resulting in 10,173ha being thinned per annum per power station, resulting in a total of 508,646ha being thinned over the project life.





The cost of thinning and after care is initially net negative for farmers, however this turns positive after Year 7 as the increase in herd sizes and income from slaughter and exports benefits farmers.



The summarised supply chain and land-use change emissions per power station, over the 25-year lifespan:

Activity	**kgCO$_2$e over 25 Years (per power station)**	**kgCO$_2$e / kWh**
Harvesting	86,939,084	0.02
Transport	15,139,200	0.00
Conversion	56,160,000	0.02
Soil Carbon	149,023,099	0.04
Livestock	460,110,621	0.12
Total	**767,372,005**	**0.20**

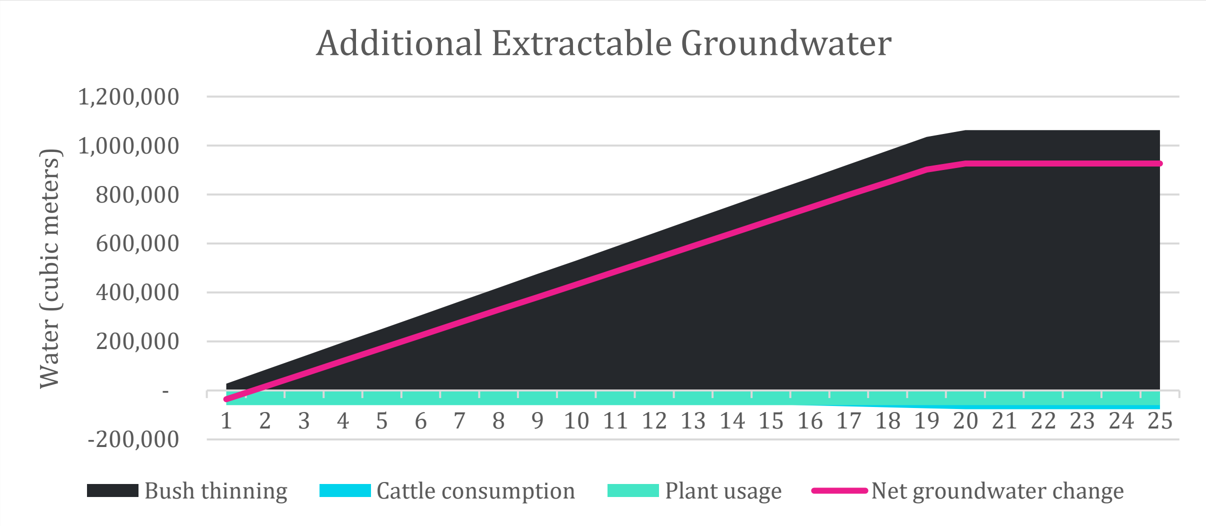
	kgCO$_2$e over 25 Years			
Grid Emission Factor	**Emitted**	**Displaced**	**Project Net**	**KgCO$_2$ per kWh**
Namibian Grid = 0.4898 (WSP)	767,372,005	-1,833,811,200	-1,066,439,195	-0.28
SAPP = 0.9644 (UNFCCC)		-2,599,833,600	-1,832,461,595	-0.49

The overall value of net emissions, in constant prices, for both power stations over the project lifespan amounts to:

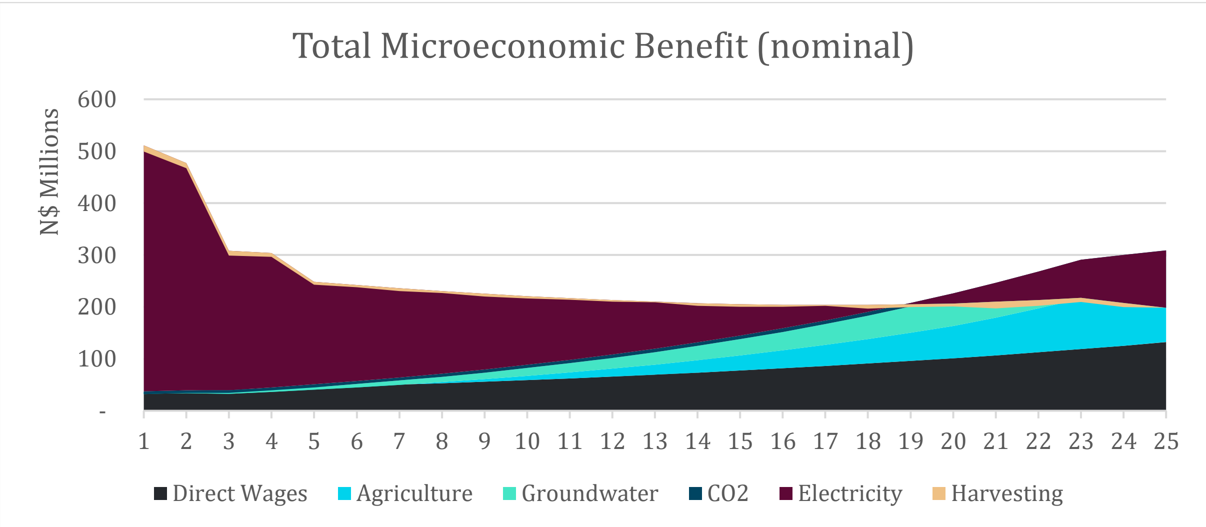
	Value of Net Emissions at beginning of operational period
Carbon Price	**NIRP NAD85**
NPV NAD	303,201,179

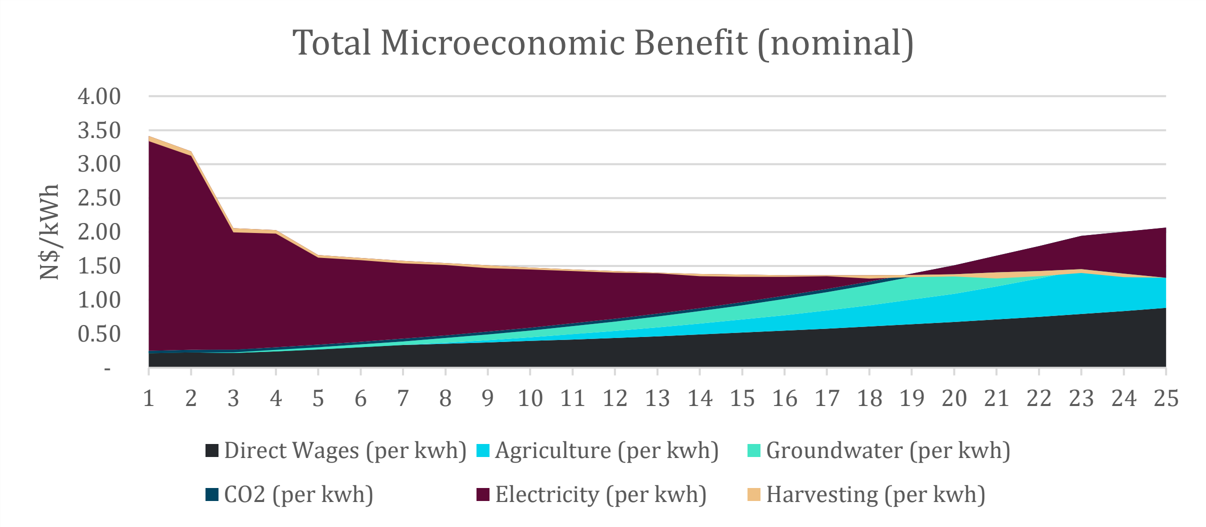
NAD/kWh	0.04

The net increase in groundwater is a total 13.8 million m^3, net of power station usage, cattle consumption, and bush regrowth. This has a net present value of NAD279.6 million, or NAD0.07/kWh.

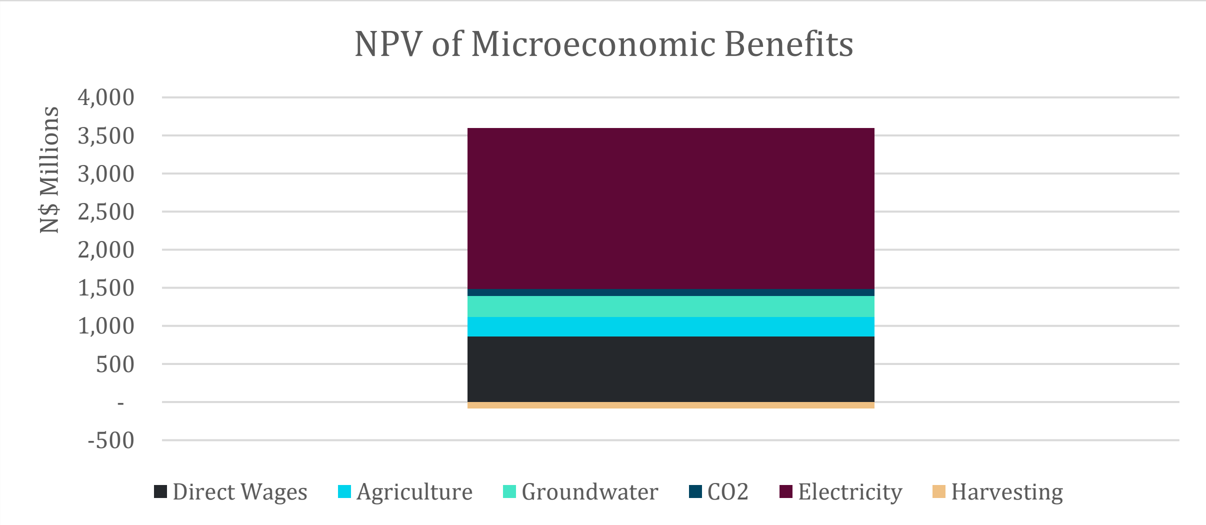


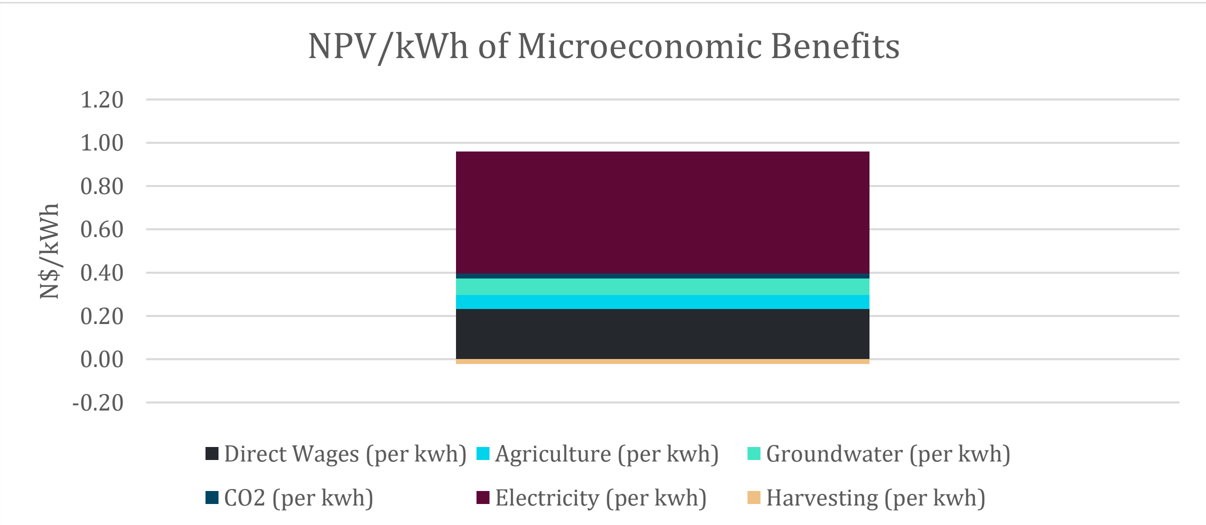
The total microeconomic benefit has a net present value of NAD3.5 billion, or NAD0.94/kWh.



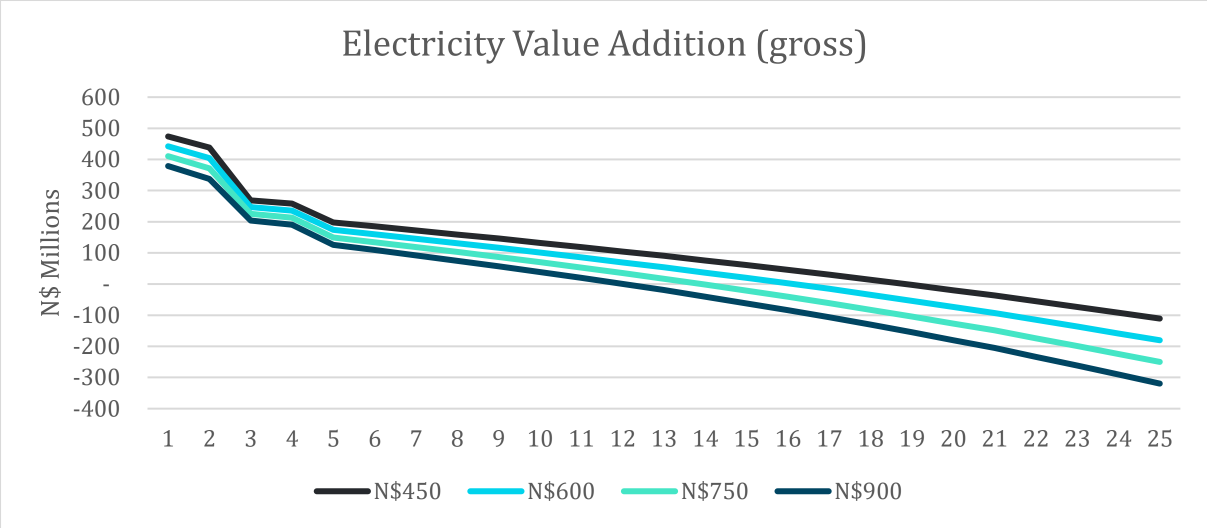


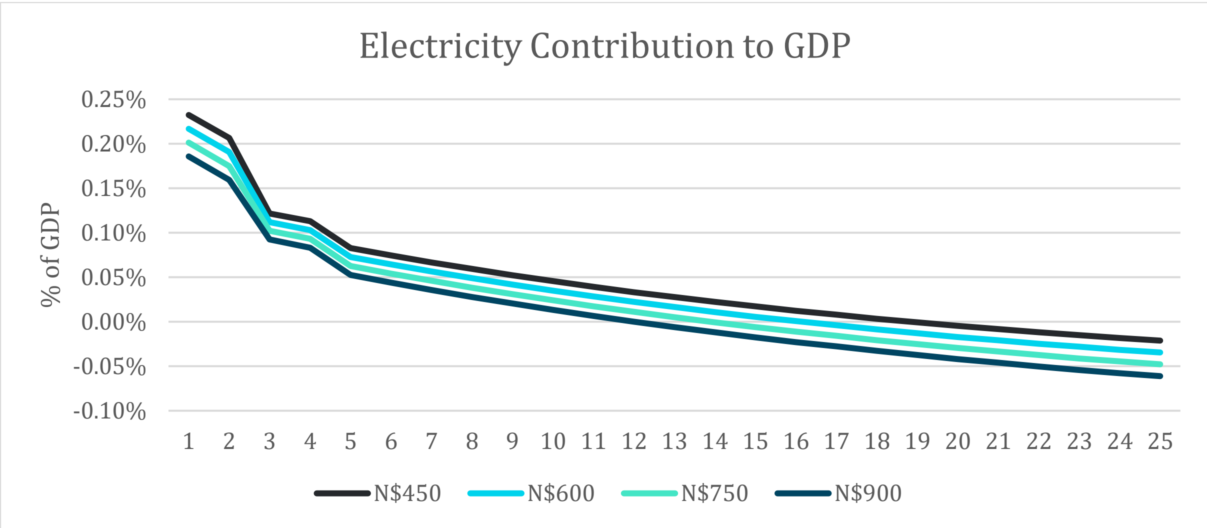
The net present value of total microeconomic benefits is estimated at NAD3.5 billion, or NAD0.94/kWh.

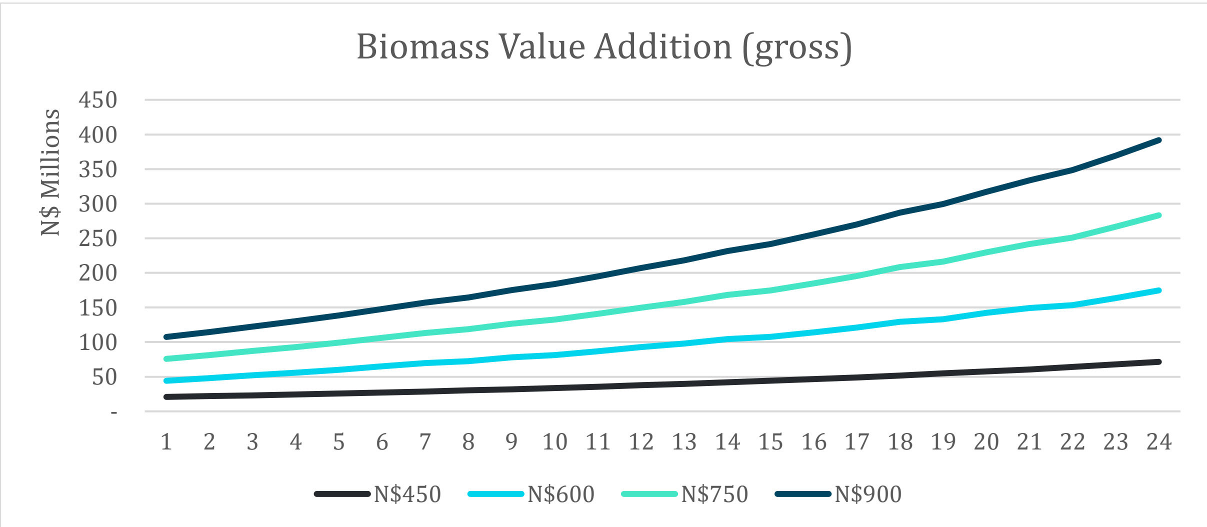


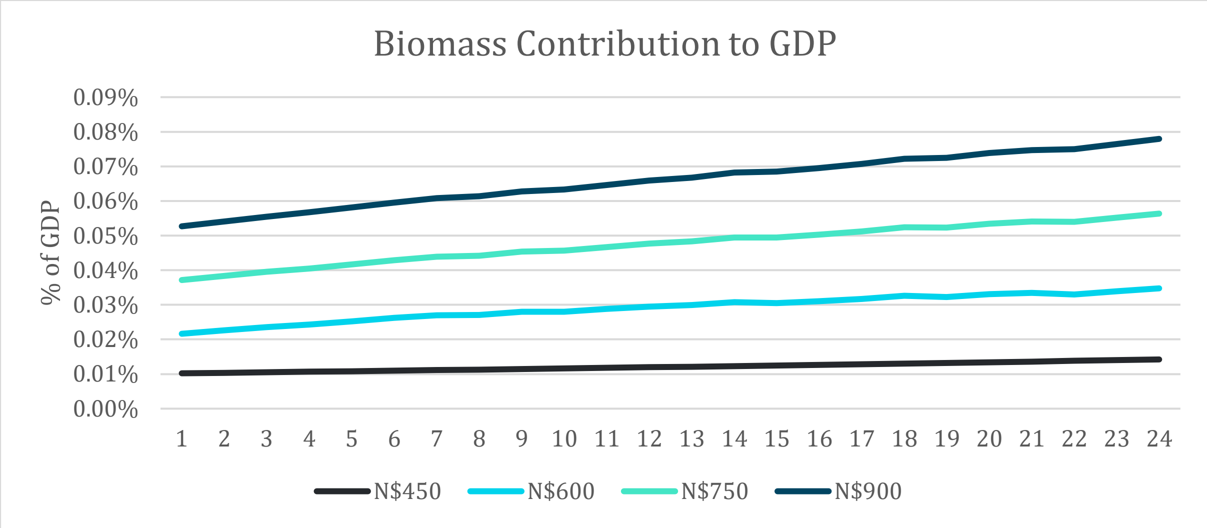


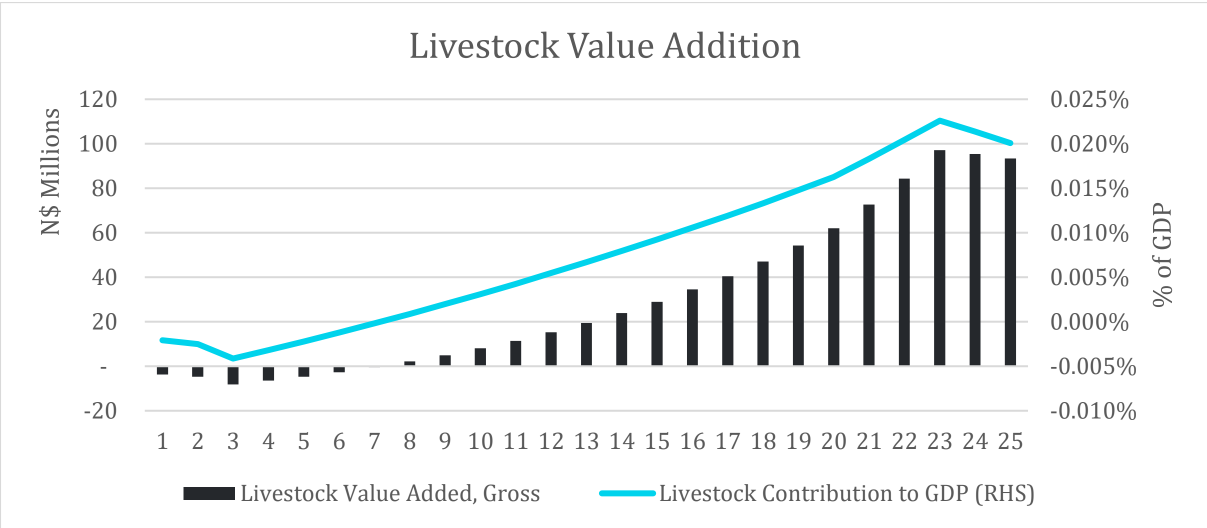
The loss-making power stations mean that value addition from electricity eventually turns negative.


Electricity Value Addition (gross)
N$ Millions
600
500
400
300
200
100
-
-100
-200
-300
-400
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
N$450
N$600
N$750
N$900

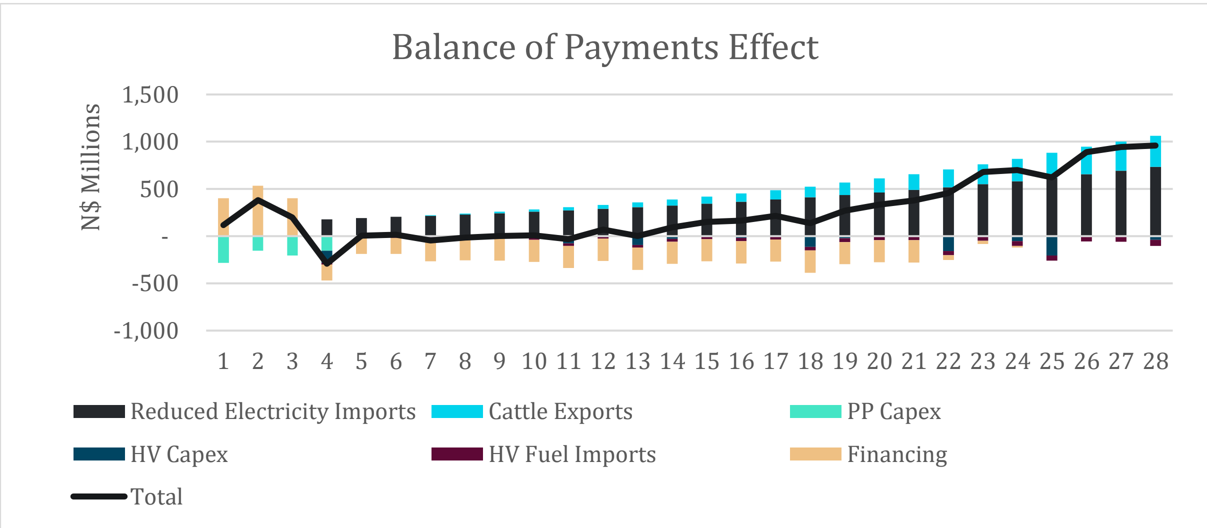

Electricity Contribution to GDP
% of GDP
0.25%
0.20%
0.15%
0.10%
0.05%
0.00%
-0.05%
-0.10%
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
N$450
N$600
N$750
N$900

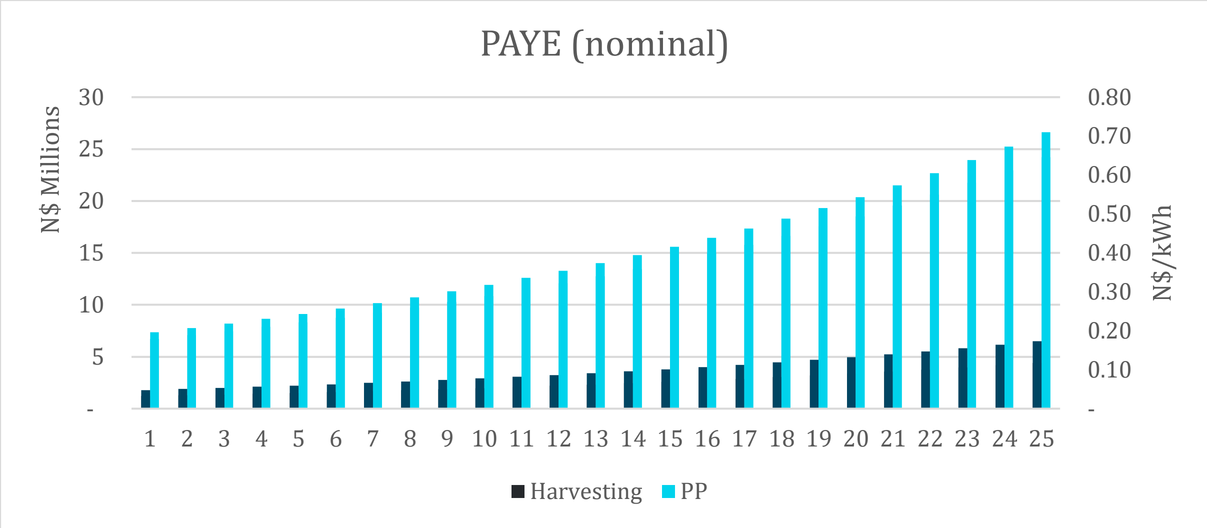

Biomass Value Addition (gross)
N$ Millions
450
400
350
300
250
200
150
100
50
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
N$450
N$600
N$750
N$900

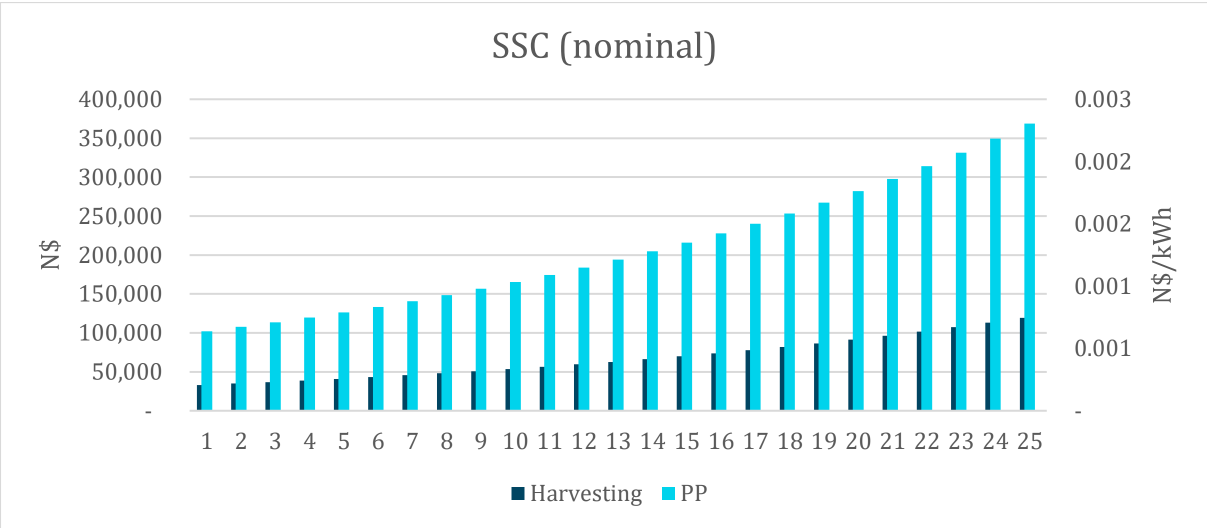


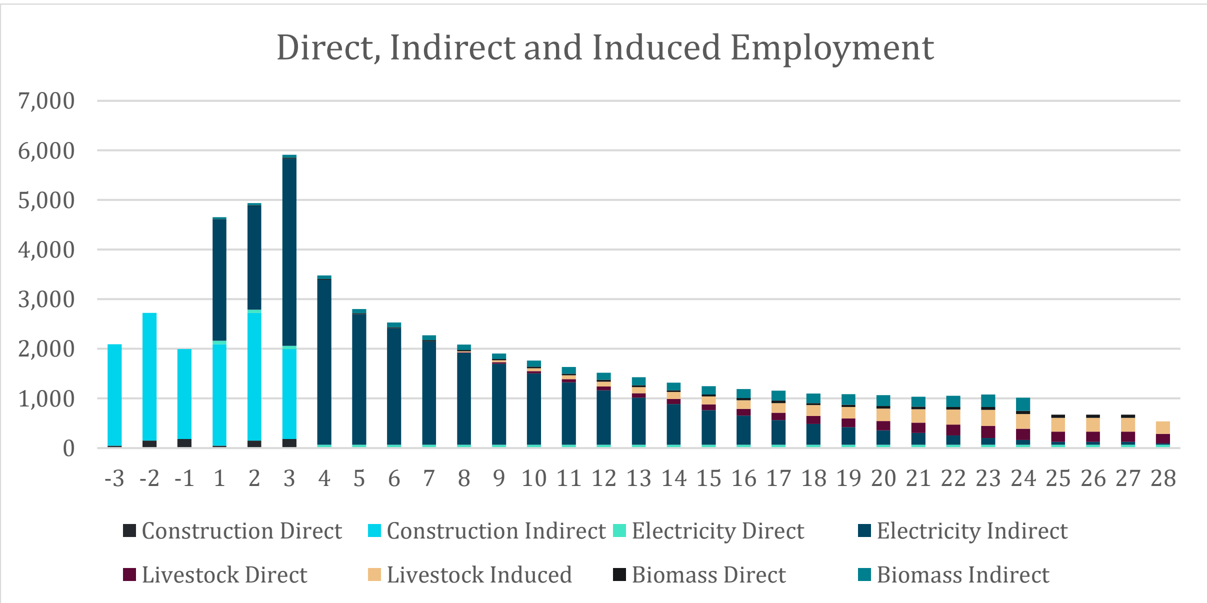


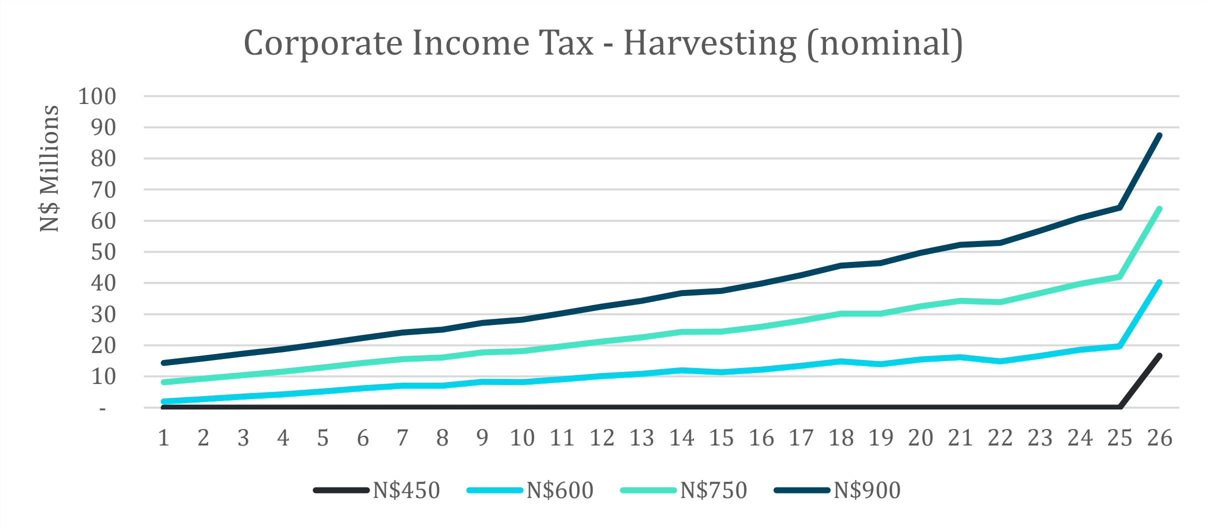
The Balance of Payments impact is overall positive, given the benefit seen in offsetting electricity imports.

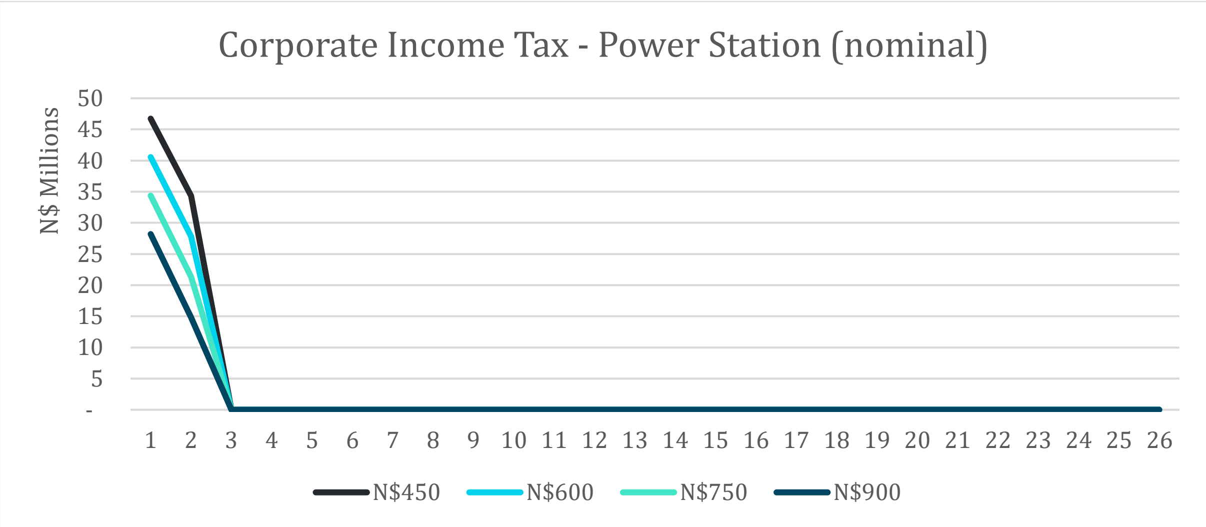


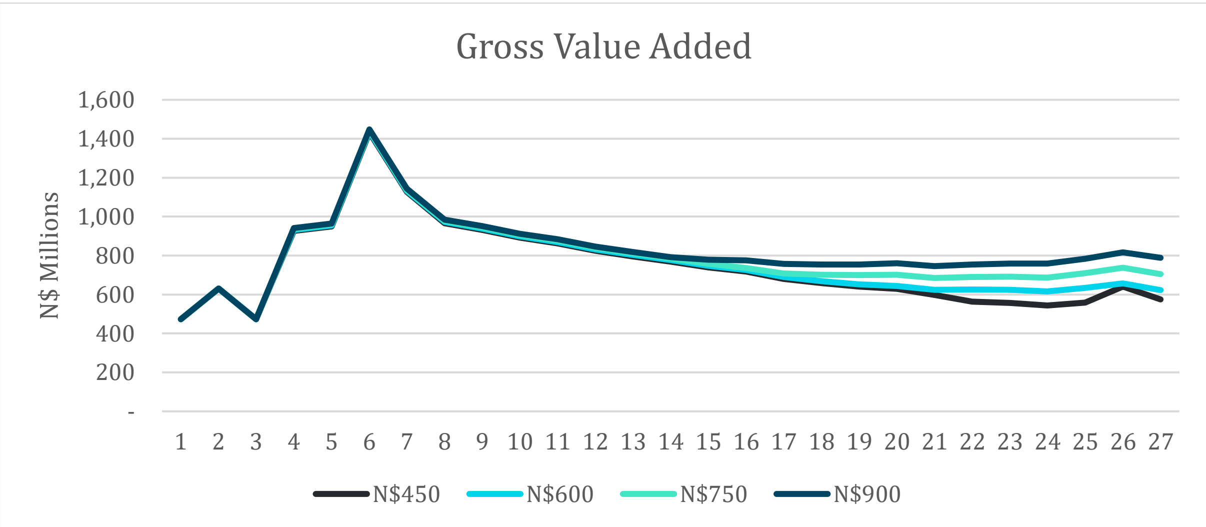

PAYE (nominal)
N$ Millions
30
25
20
15
10
5
-
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
-
N$/kWh
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
Harvesting
PP

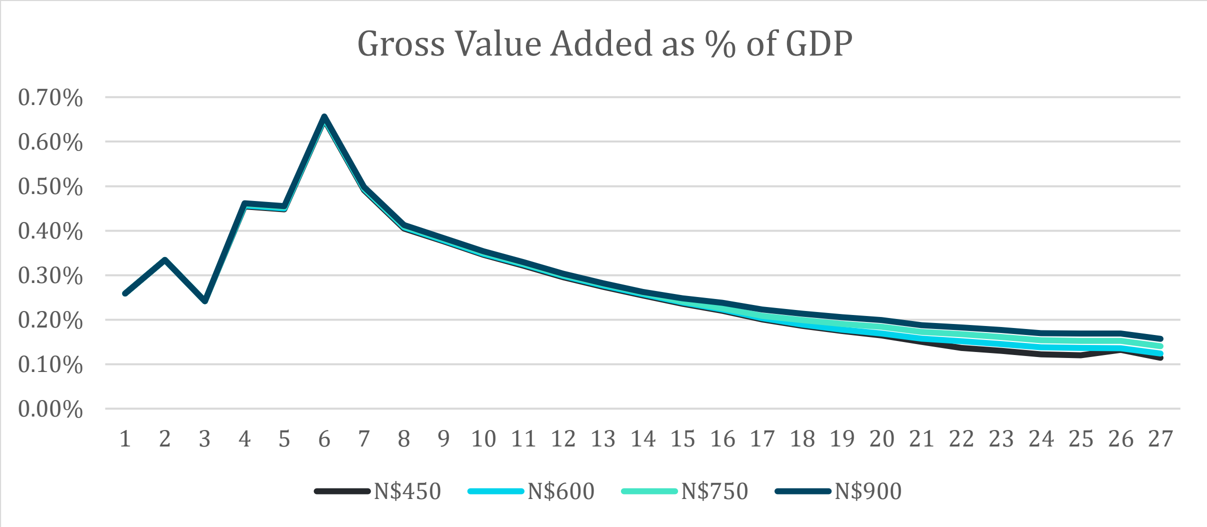

SSC (nominal)
N$
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
-
0.003
0.002
0.002
0.001
0.001
-
N$/kWh
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
Harvesting
PP

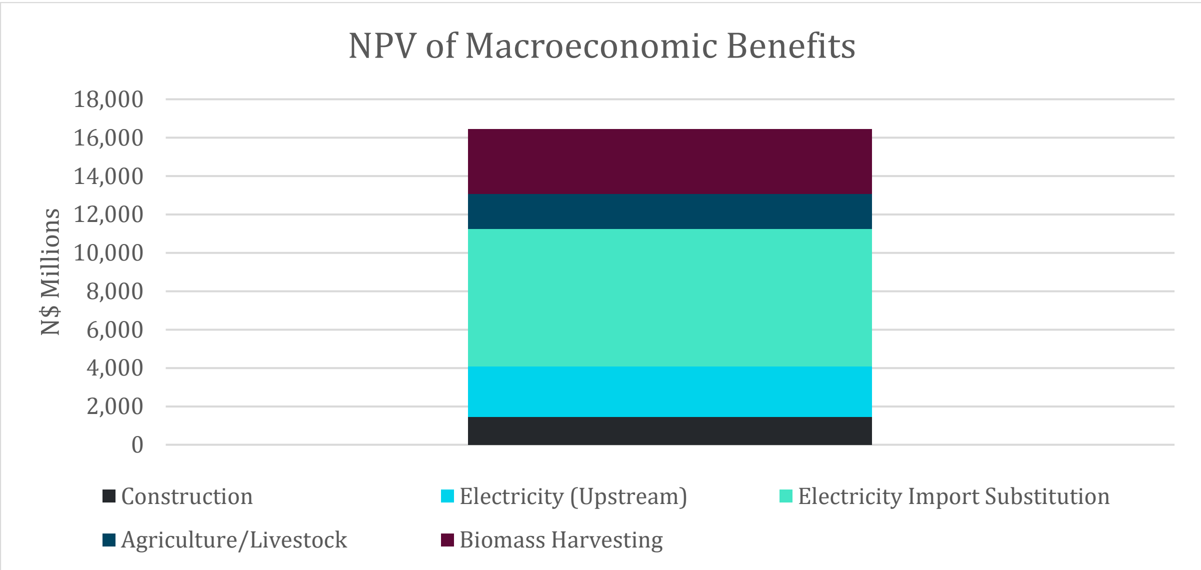

Direct, Indirect and Induced Employment
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
-3 -2 -1 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28
Construction Direct
Construction Indirect
Electricity Direct
Electricity Indirect
Livestock Direct
Livestock Induced
Biomass Direct
Biomass Indirect

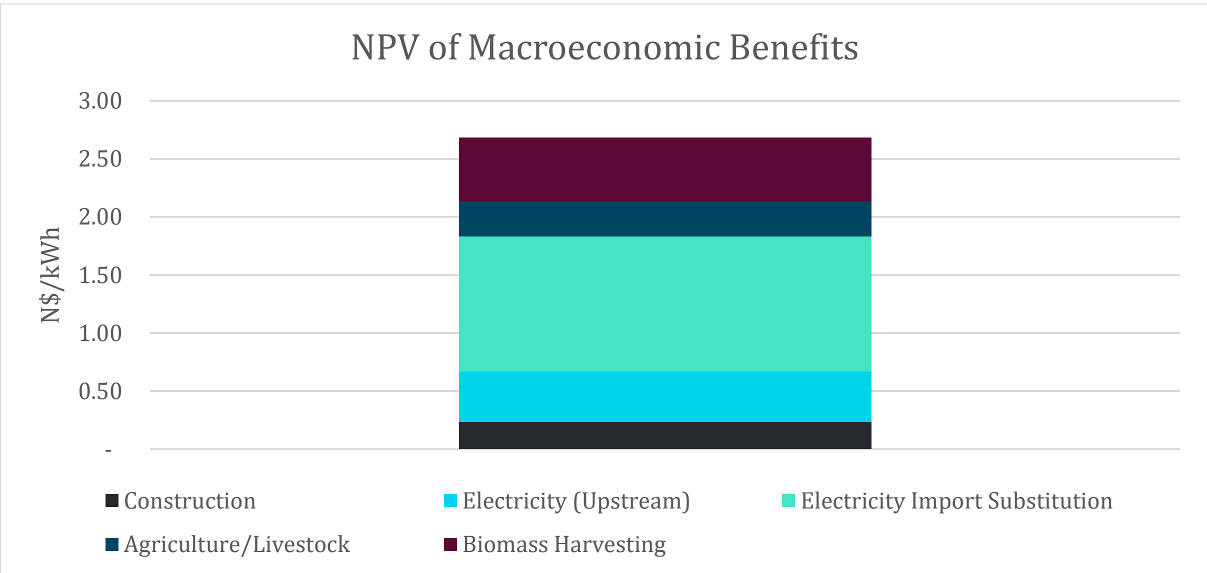

Corporate Income Tax - Harvesting (nominal)
N$ Millions
100
90
80
70
60
50
40
30
20
10
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26
N$450
N$600
N$750
N$900


Corporate Income Tax - Power Station (nominal)
N$ Millions
50
45
40
35
30
25
20
15
10
5
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26
N$450
N$600
N$750
N$900


Gross Value Added
N$ Millions
1,600
1,400
1,200
1,000
800
600
400
200
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27
N$450
N$600
N$750
N$900


Gross Value Added as % of GDP
0.70%
0.60%
0.50%
0.40%
0.30%
0.20%
0.10%
0.00%
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27
N$450
N$600
N$750
N$900

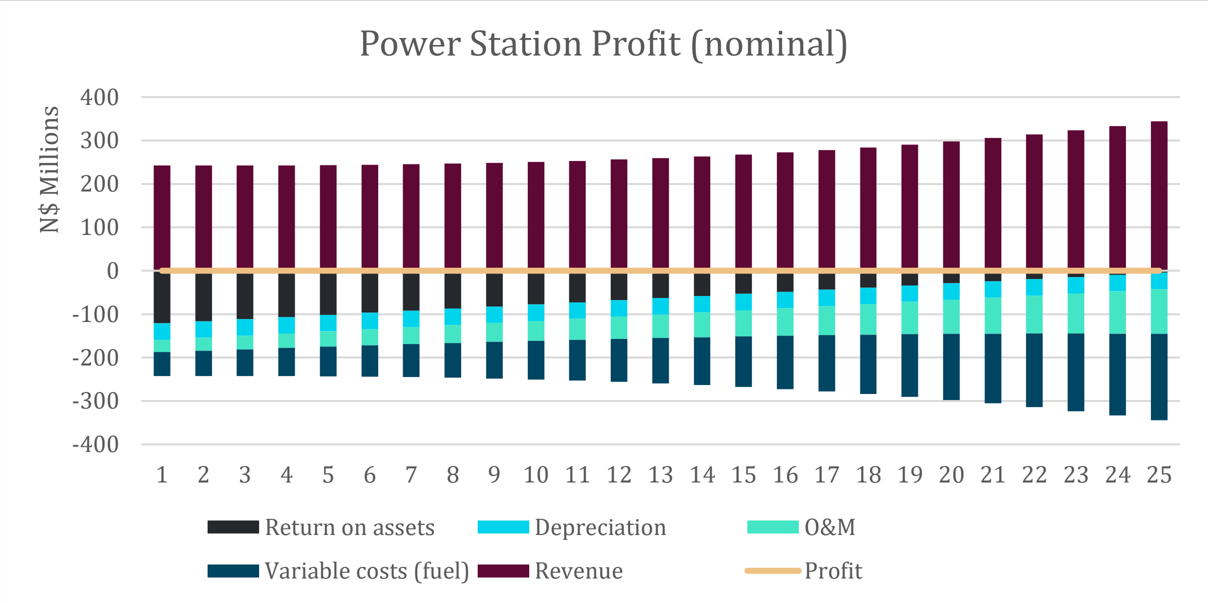

NPV of Macroeconomic Benefits
N$ Millions
18,000
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
Construction
Electricity (Upstream)
Electricity Import Substitution
Agriculture/Livestock
Biomass Harvesting


NPV of Macroeconomic Benefits
N$/kWh
3.00
2.50
2.00
1.50
1.00
0.50
-
Construction
Electricity (Upstream)
Electricity Import Substitution
Agriculture/Livestock
Biomass Harvesting

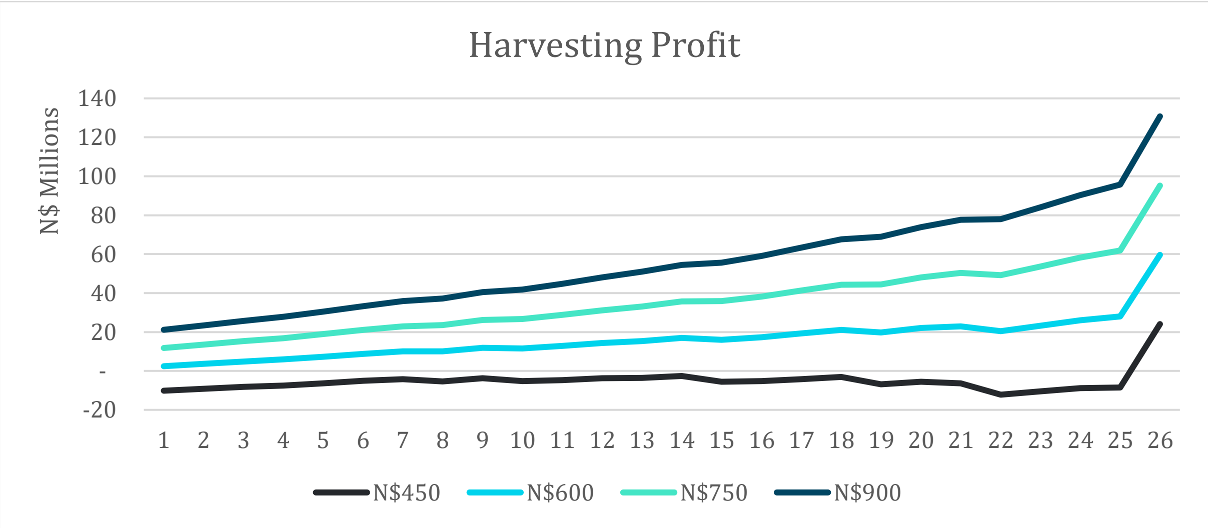
Appendix 8

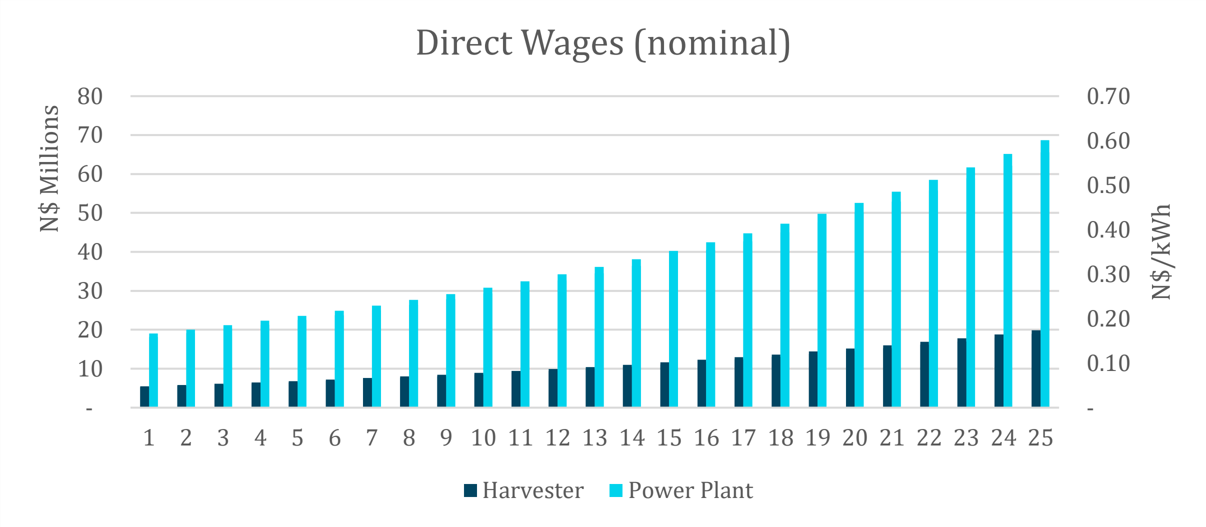
Scenario:

- Power station = 16MWe pilot
- Capacity Factor = 85%
- Price per kWh installed = USD 3500/kW

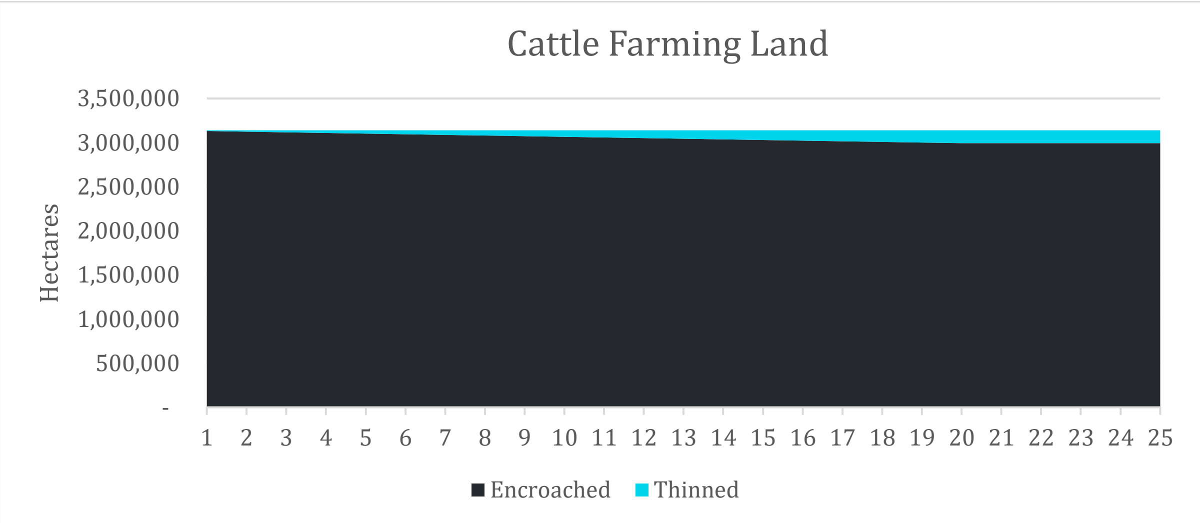


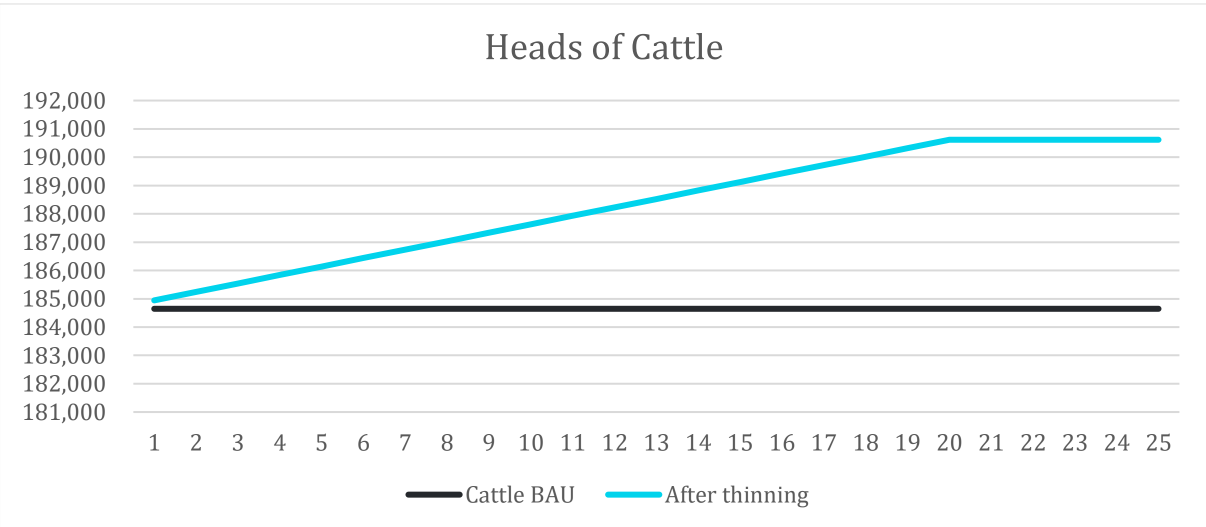
Harvesting is profitable for every year at the three higher price points, while remains mostly loss-making at NAD450/t.

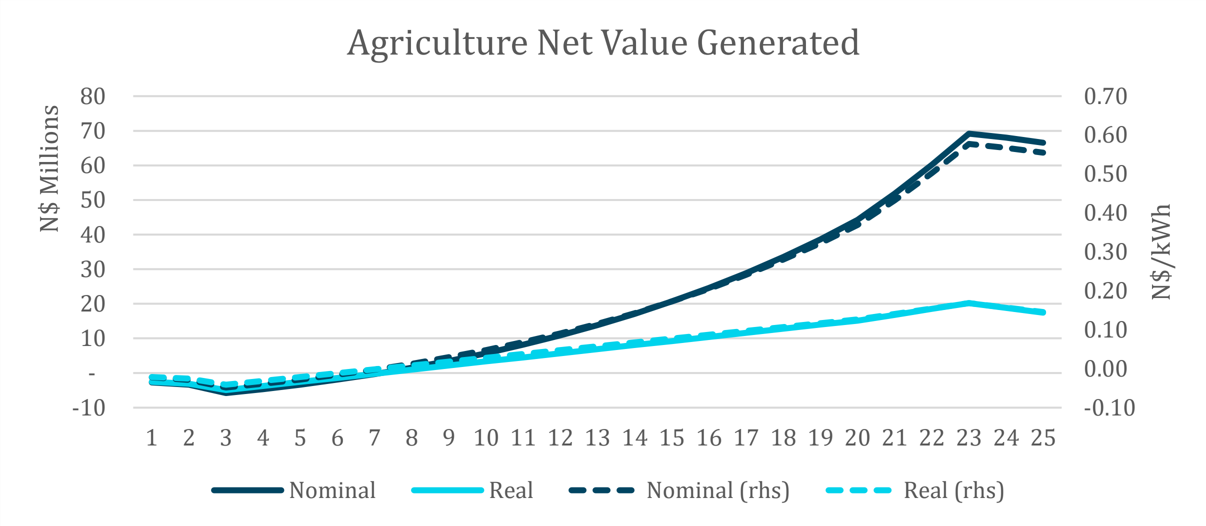




The 16MWe pilot power station has an annual fuel requirement of 91,689.8t, resulting in 7,248ha being bush thinned per year (or 181,205ha over the 25-year lifespan). The increased carrying capacity will allow for an additional 5,969 cattle over the full project period.







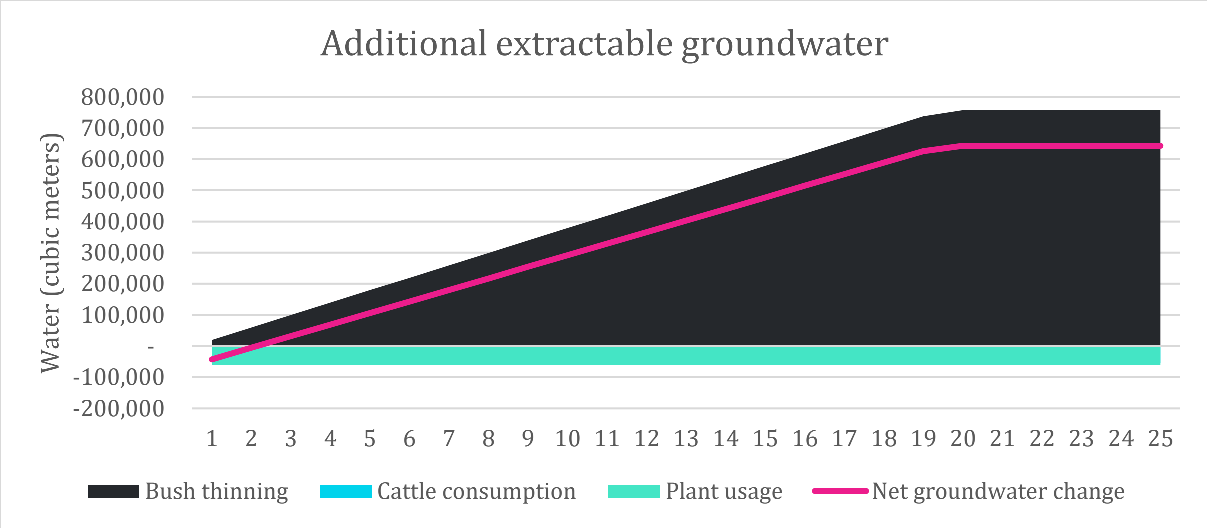
The summarised supply chain and land-use change emissions over the power station's 25-year lifespan:

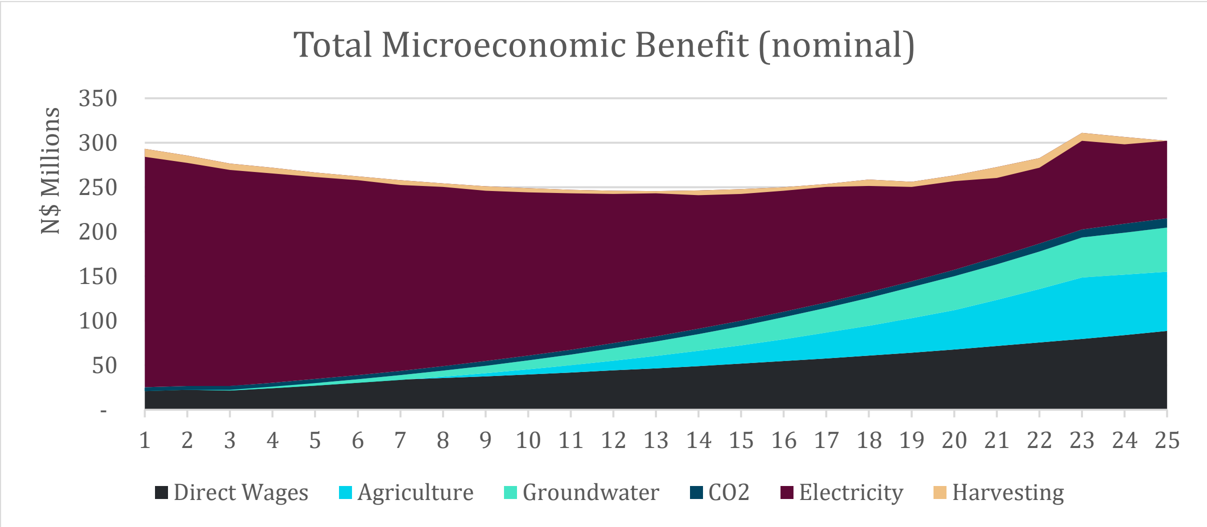
Activity	**$kgCO_2e$ over 25 Years**	**$kgCO_2e$ / kWh**
Harvesting	61,944,098	0.02
Transport	10,786,680	0.00
Conversion	44,928,000	0.02
Soil Carbon	106,178,958	0.04
Livestock	327,817,789	0.11
Total	**551,655,526**	**0.18**

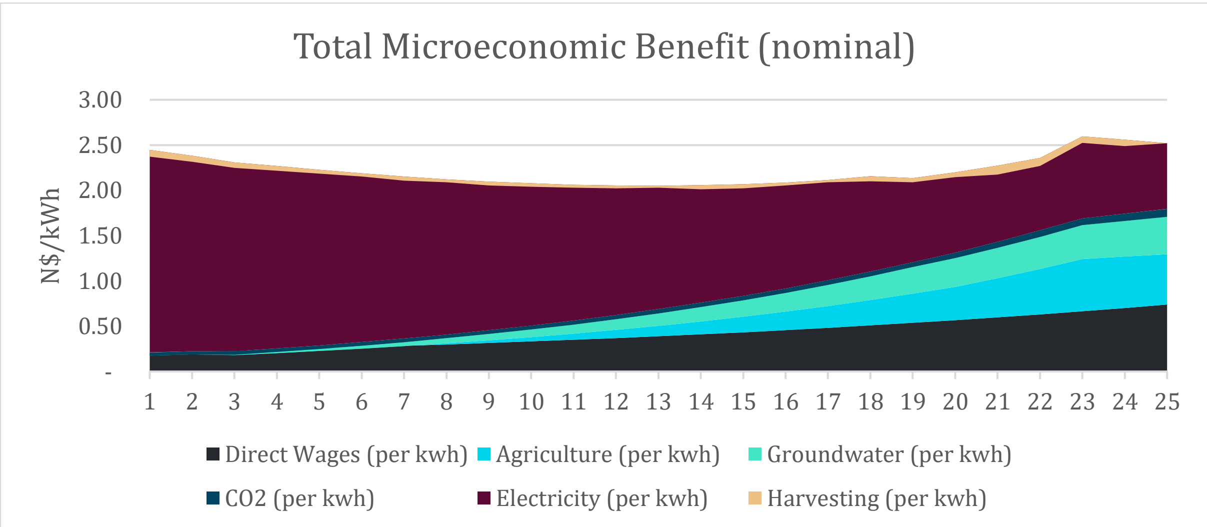
	$kgCO_2e$ over 25 Years			
Grid Emission Factor	**Emitted**	**Displaced**	**Project Net**	**$KgCO_2$ per kWh**
Namibian Grid = 0.4898 (WSP)	551,655,526	-1,467,048,960	-915,393,434	-0.31
SAPP = 0.9644 (UNFCCC)		-2,888,570,880	-2,336,915,354	-0.78

	Value of Net Emissions at beginning of operational period
Carbon Price	**NIRP NAD85**
NPV NAD	193,334,336
NAD/kWh	0.06

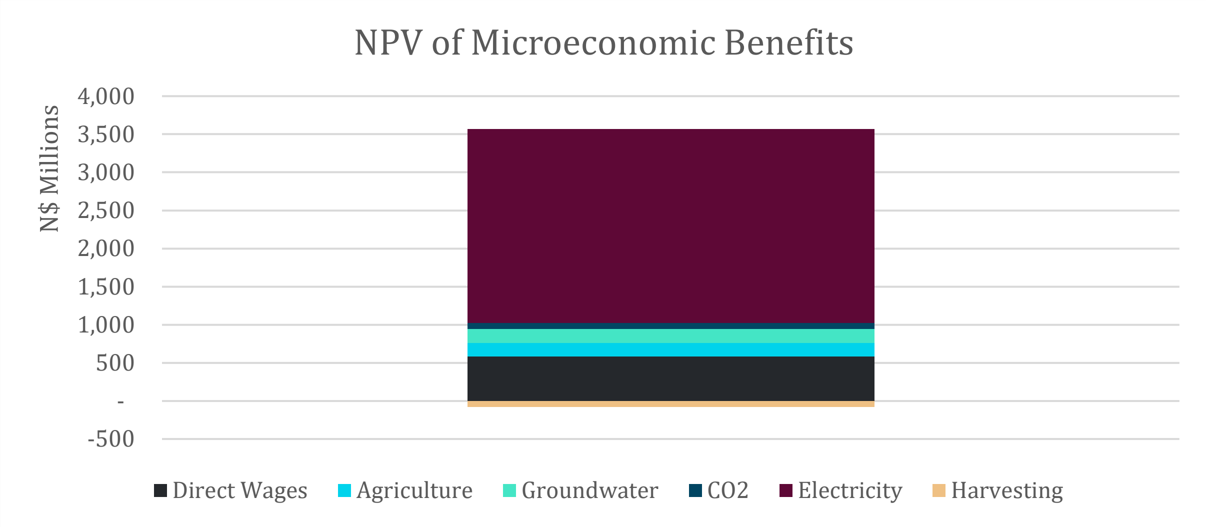
The net increase in groundwater attributable to the project is estimated at 9.4 million m^3, with a net present value of NAD190.5 million.

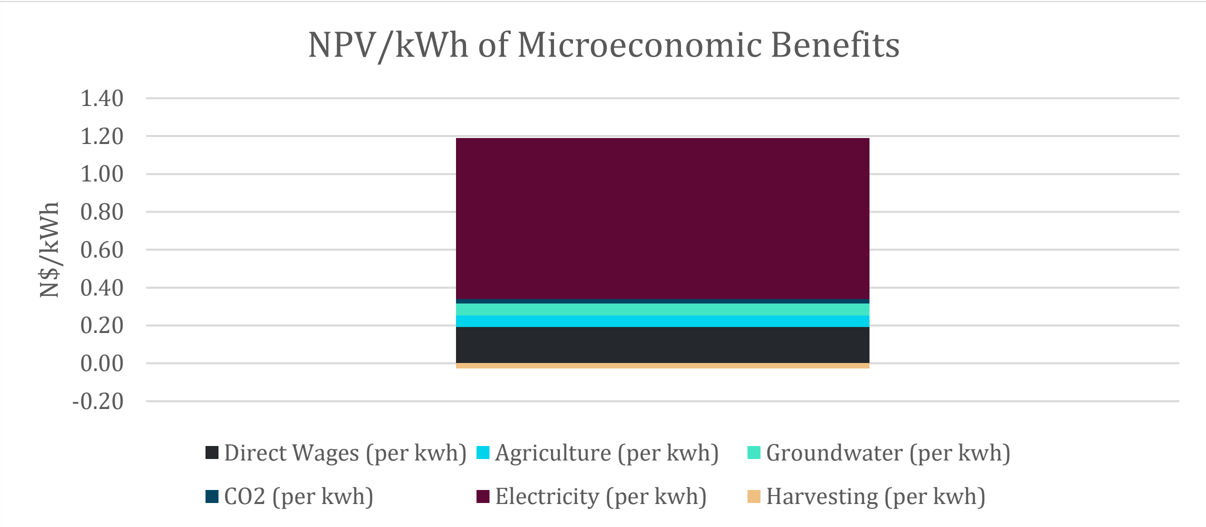


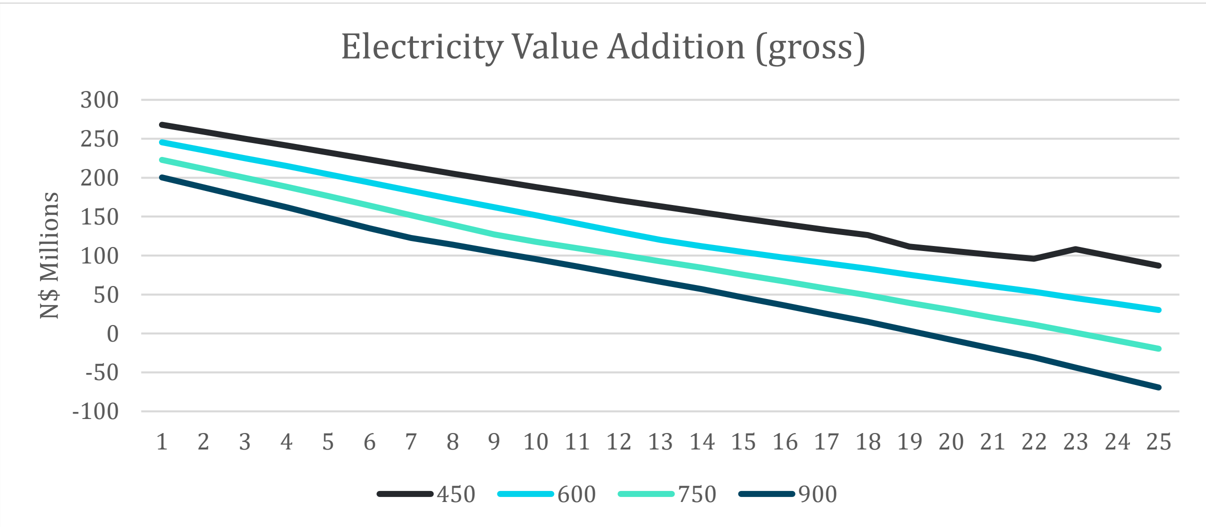


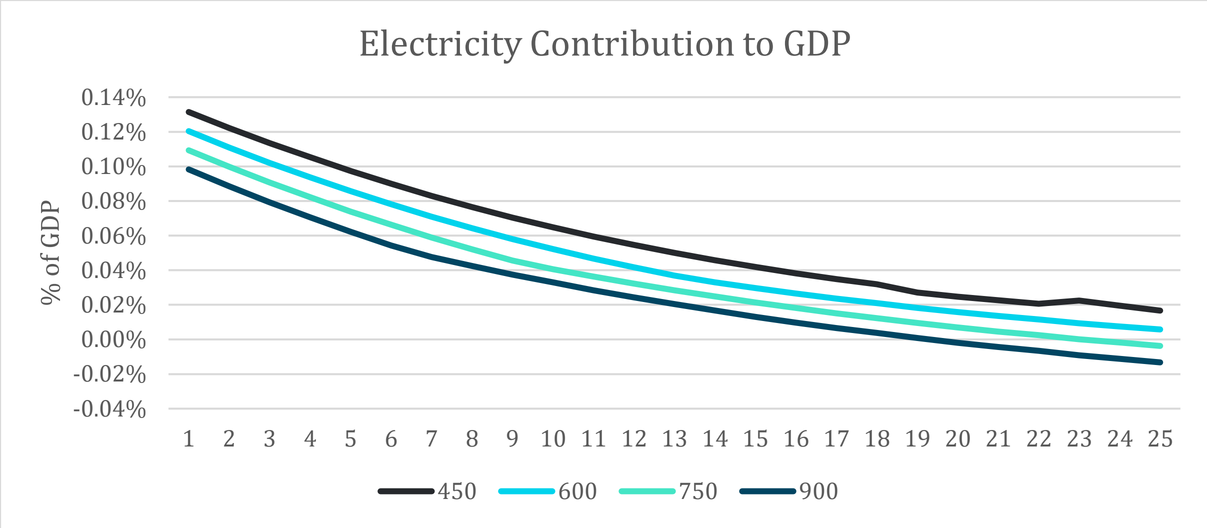


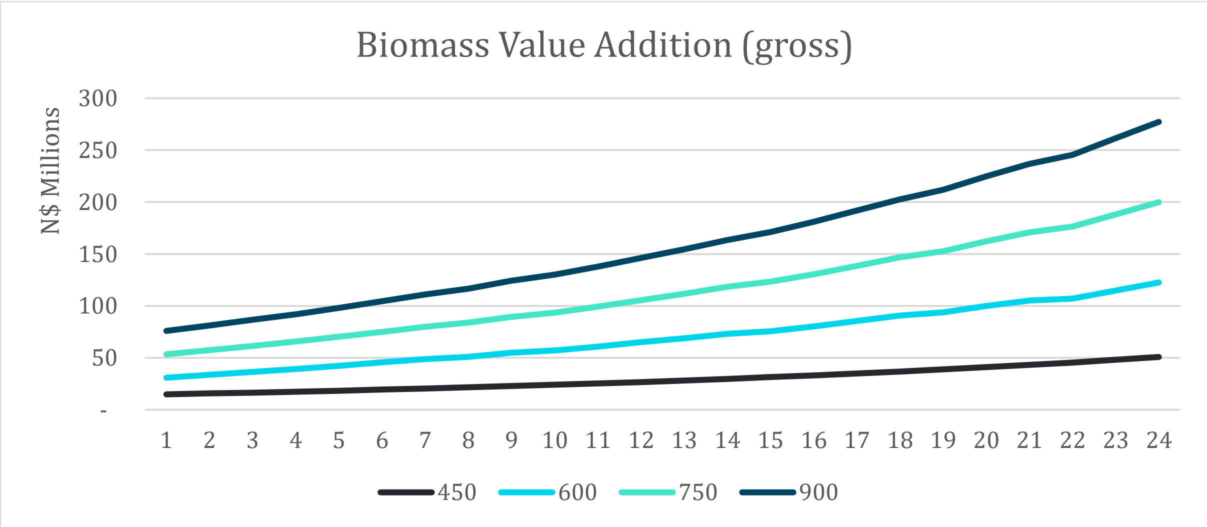
The net present value of microeconomic benefits totals NAD3.5 billion, or NAD1.16/kWh.

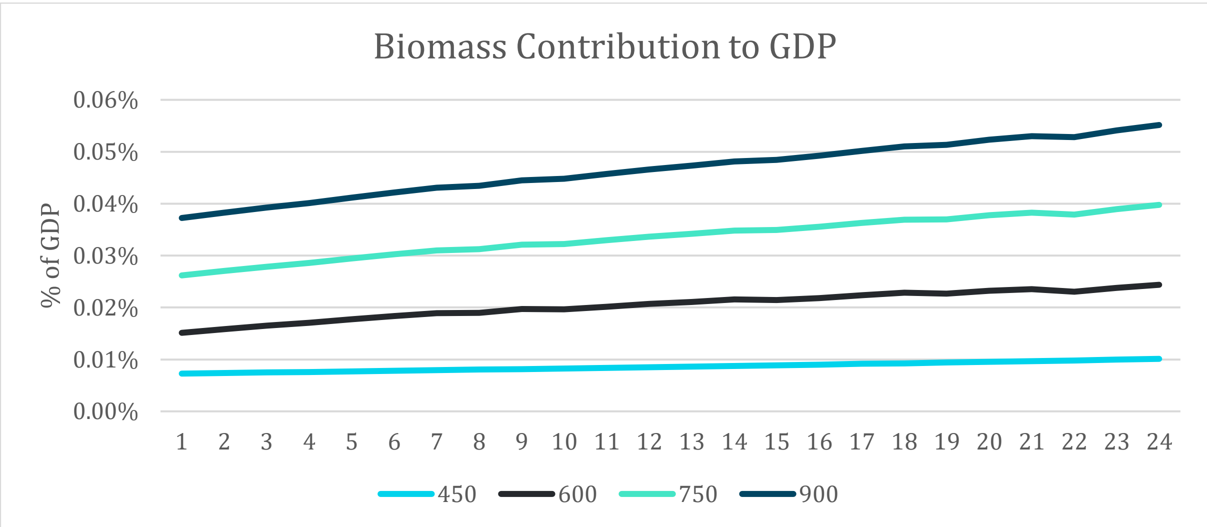

NPV of Microeconomic Benefits
N$ Millions
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
-
-500
Direct Wages
Agriculture
Groundwater
CO2
Electricity
Harvesting

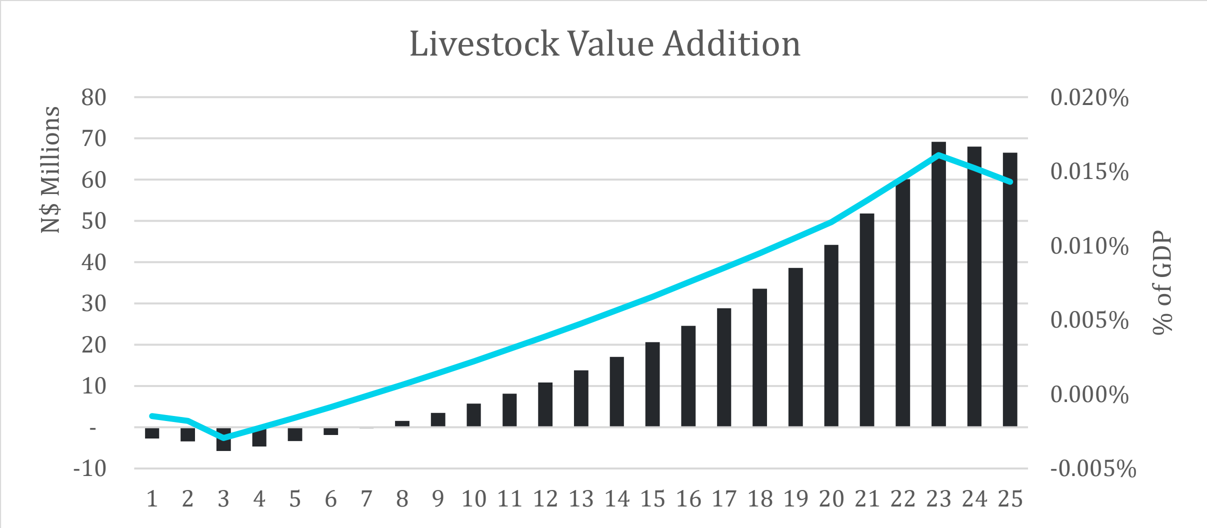

NPV/kWh of Microeconomic Benefits
N$/kWh
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
-0.20
Direct Wages (per kwh)
Agriculture (per kwh)
Groundwater (per kwh)
CO2 (per kwh)
Electricity (per kwh)
Harvesting (per kwh)

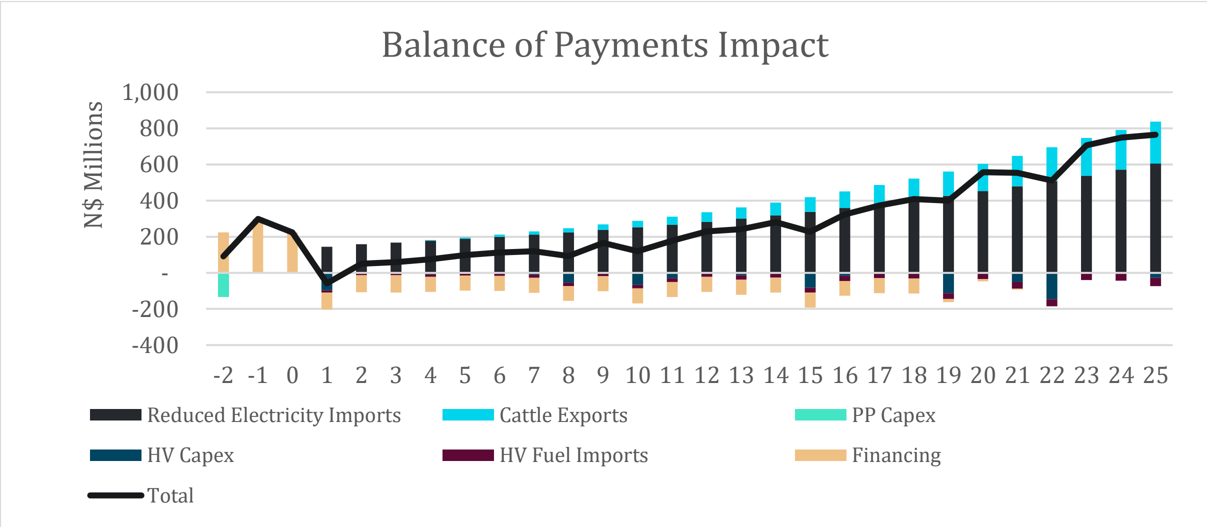

Electricity Value Addition (gross)
N$ Millions
300
250
200
150
100
50
0
-50
-100
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
450
600
750
900

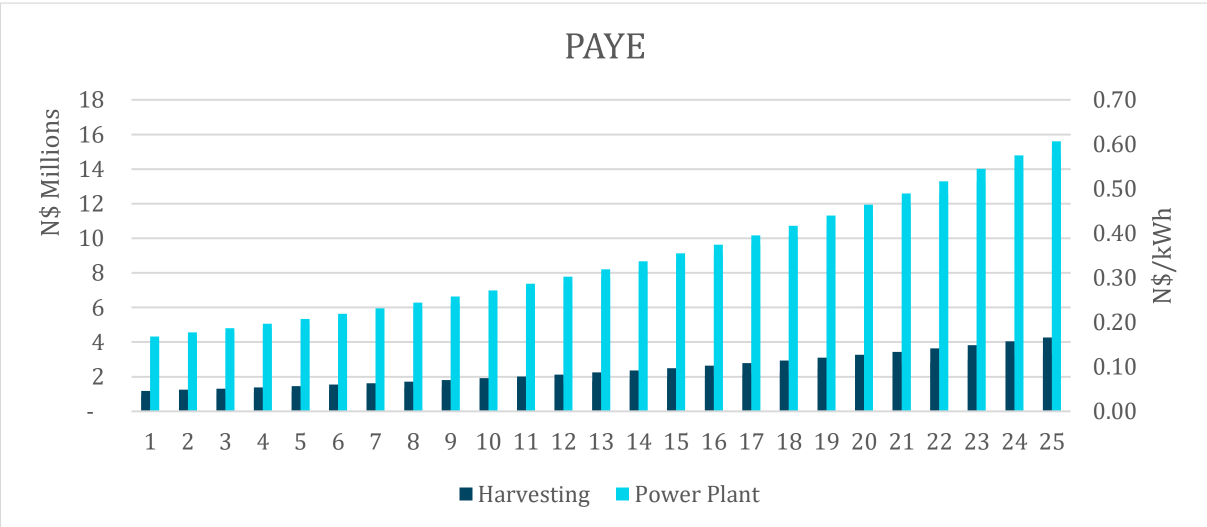

Electricity Contribution to GDP
% of GDP
0.14%
0.12%
0.10%
0.08%
0.06%
0.04%
0.02%
0.00%
-0.02%
-0.04%
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
450 600 750 900

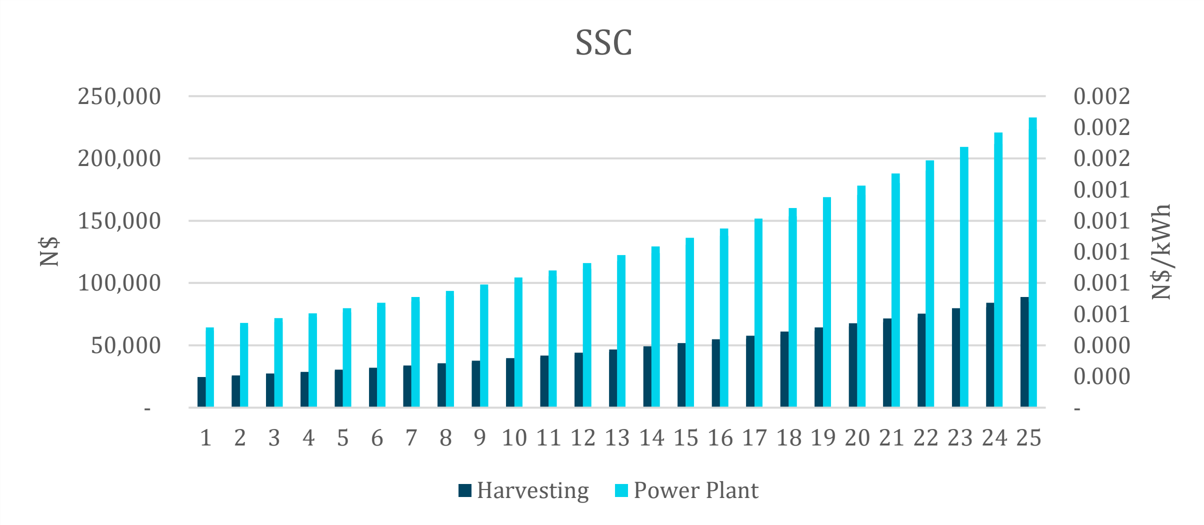

Biomass Value Addition (gross)
N$ Millions
300
250
200
150
100
50
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
450 600 750 900


Biomass Contribution to GDP
% of GDP
0.06%
0.05%
0.04%
0.03%
0.02%
0.01%
0.00%
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
450 600 750 900

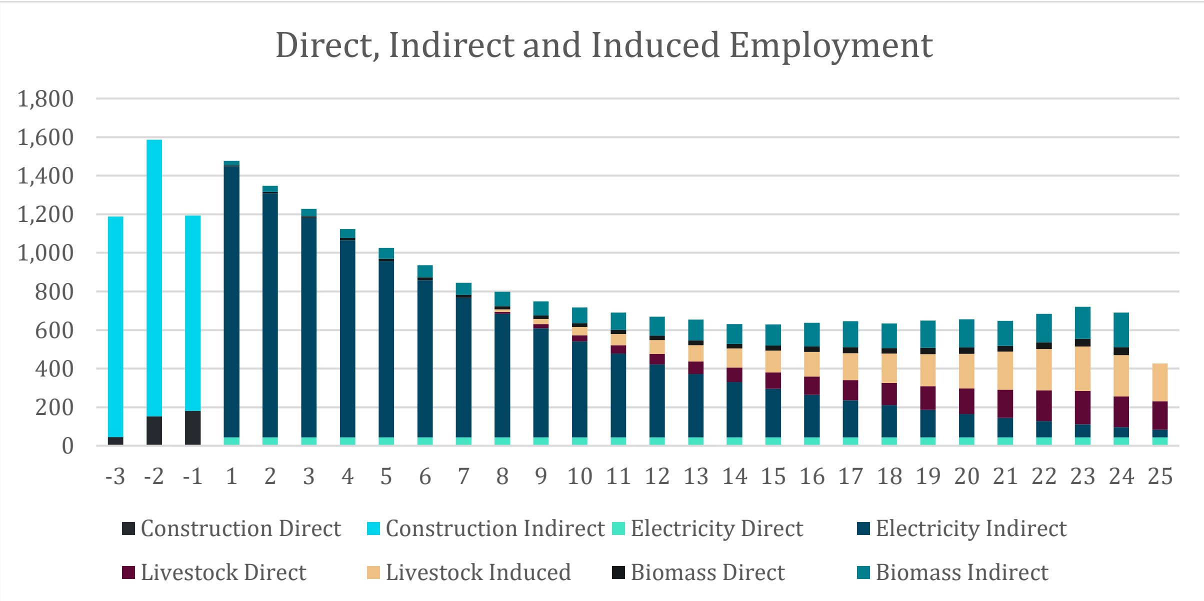

Livestock Value Addition
N$ Millions
% of GDP
80
70
60
50
40
30
20
10
-
-10
0.020%
0.015%
0.010%
0.005%
0.000%
-0.005%
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25

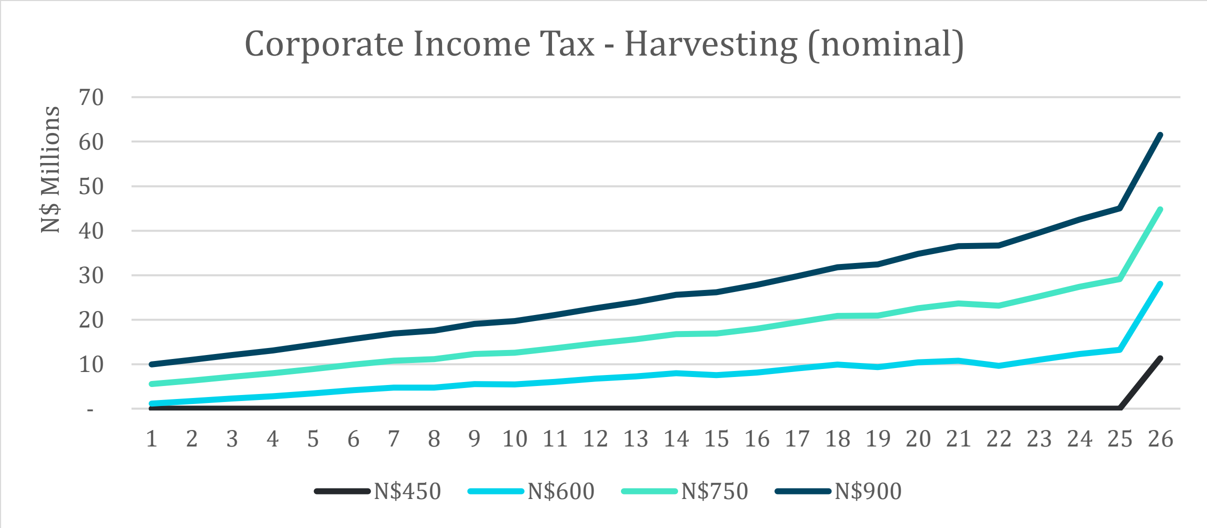

Balance of Payments Impact
N$ Millions
1,000
800
600
400
200
-
-200
-400
-2 -1 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
Reduced Electricity Imports
Cattle Exports
PP Capex
HV Capex
HV Fuel Imports
Financing
Total

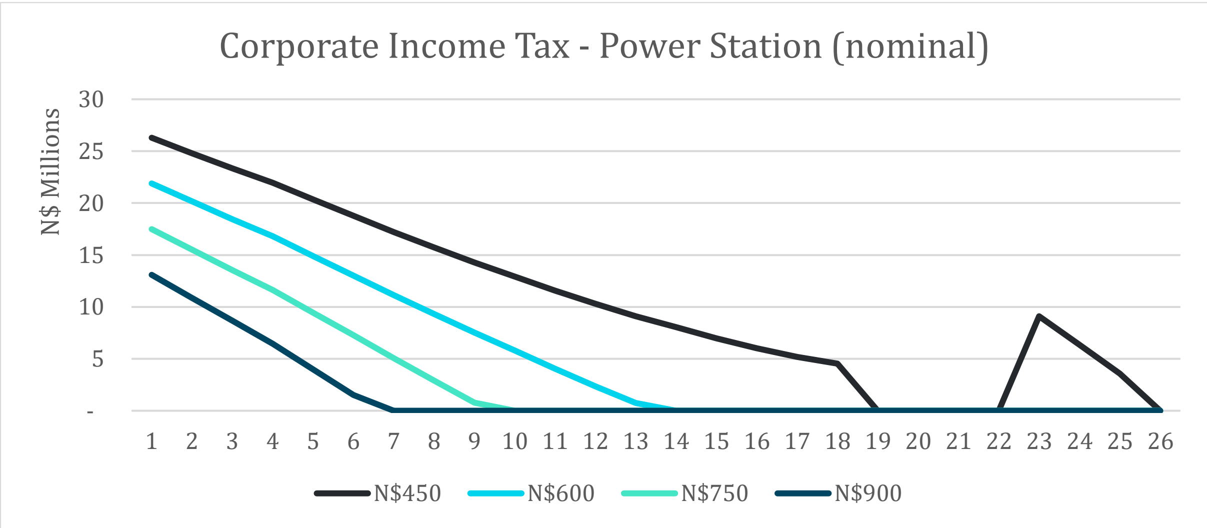

PAYE
N$ Millions
N$/kWh
18
16
14
12
10
8
6
4
2
-
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
Harvesting
Power Plant

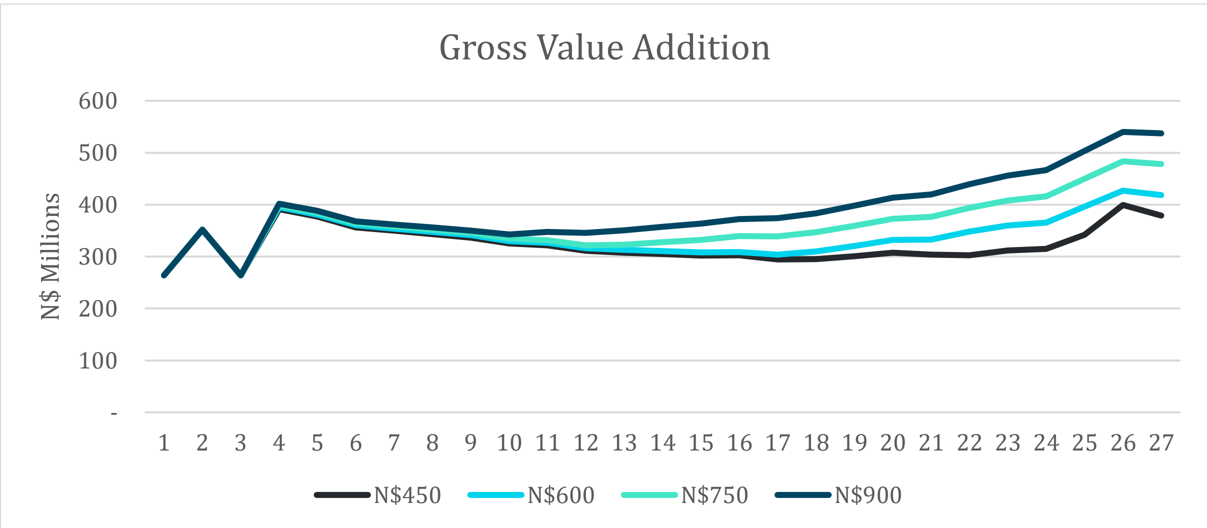


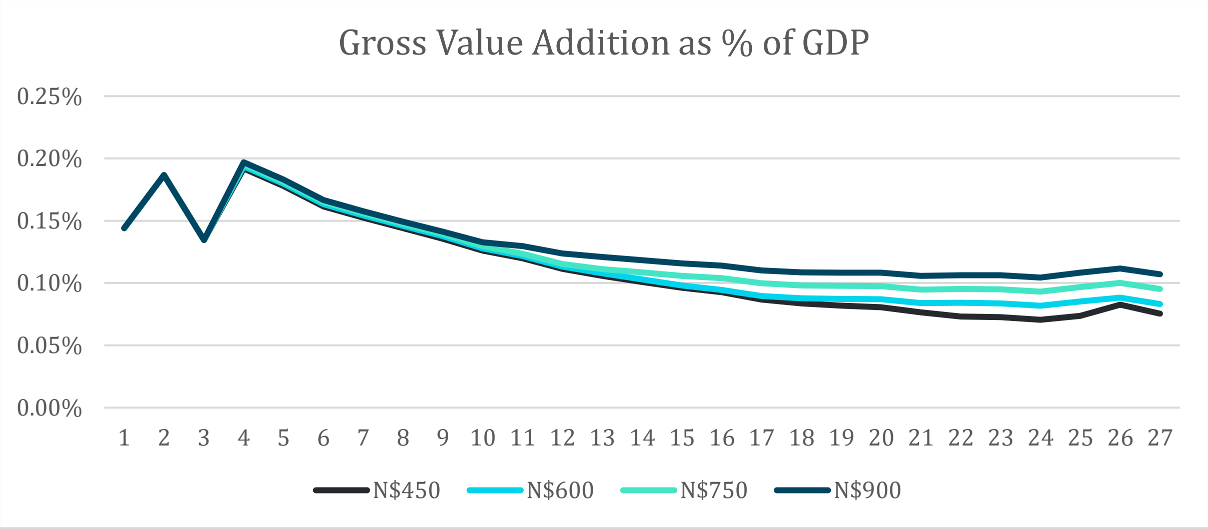
Harvesting is only profitable from the NAD600/t biomass price point and upwards, thereby only contributing to corporate income tax at the higher price points, whereas the power station sees its best profitability at the lowest price point (NAD450/t) but does not pay corporate income tax for four years at that level.



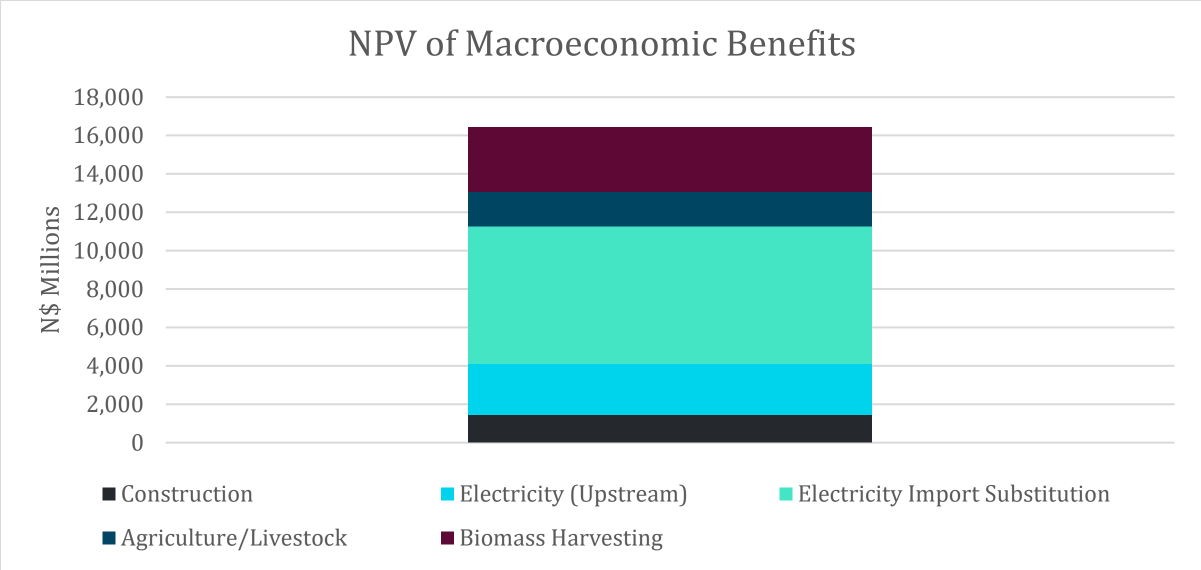

Corporate Income Tax - Harvesting (nominal)
N$ Millions
70
60
50
40
30
20
10
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26
N$450
N$600
N$750
N$900

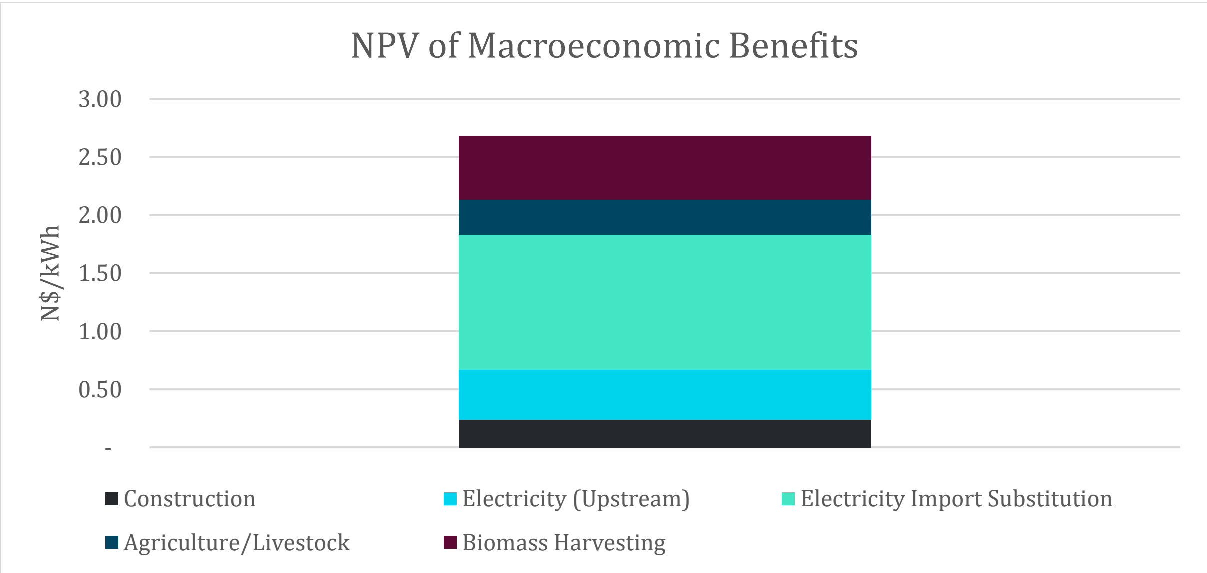

Corporate Income Tax - Power Station (nominal)
N$ Millions
30
25
20
15
10
5
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26
N$450
N$600
N$750
N$900


Gross Value Addition
N$ Millions
600
500
400
300
200
100
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27
N$450
N$600
N$750
N$900



NAD Million	Multiplier	Year		
		1	2	3
Construction Value Addition, Gross		111.85	149.14	111.85
- Downstream	0.21	23.61	31.48	23.61
- Upstream	2.15	240.24	320.31	240.24
Total (Multiplied Value Addition)	2.36	263.84	351.79	263.84
Construction Value Addition to GDP		**0.06%**	**0.08%**	**0.06%**
Multiplied Value Addition to GDP		**0.14%**	**0.19%**	**0.13%**
Value addition/kWh		2.20	2.94	2.20
Value addition/kWh (real)		1.86	2.34	1.66

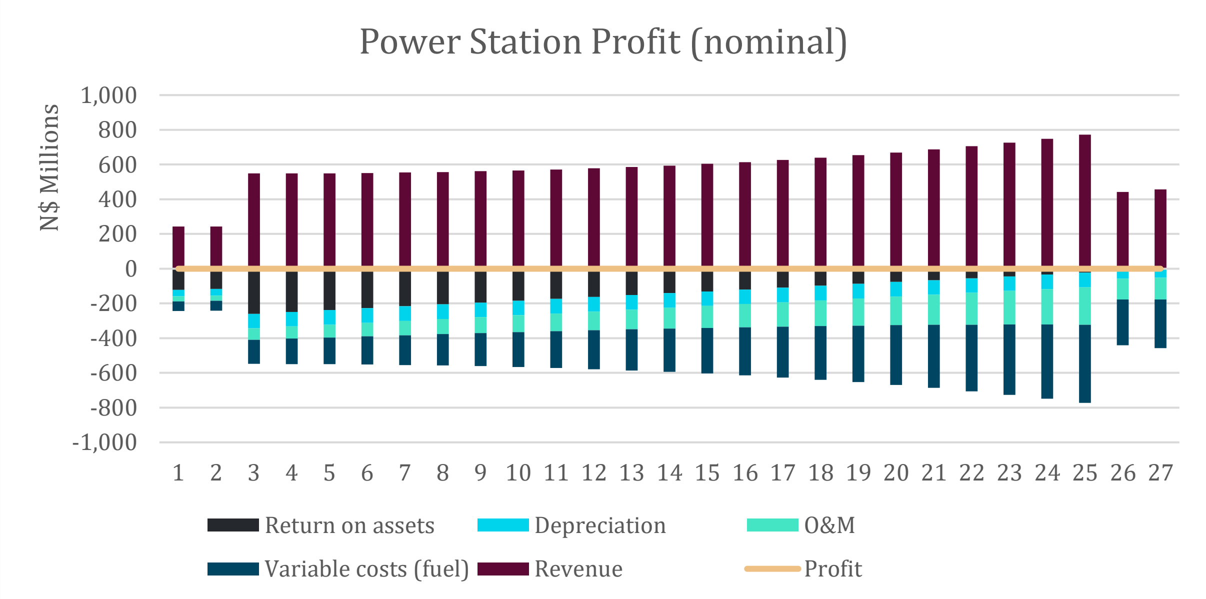

NPV of Macroeconomic Benefits
N$ Millions
18,000
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
Construction
Electricity (Upstream)
Electricity Import Substitution
Agriculture/Livestock
Biomass Harvesting


NPV of Macroeconomic Benefits
N$/kWh
3.00
2.50
2.00
1.50
1.00
0.50
-
Construction
Electricity (Upstream)
Electricity Import Substitution
Agriculture/Livestock
Biomass Harvesting

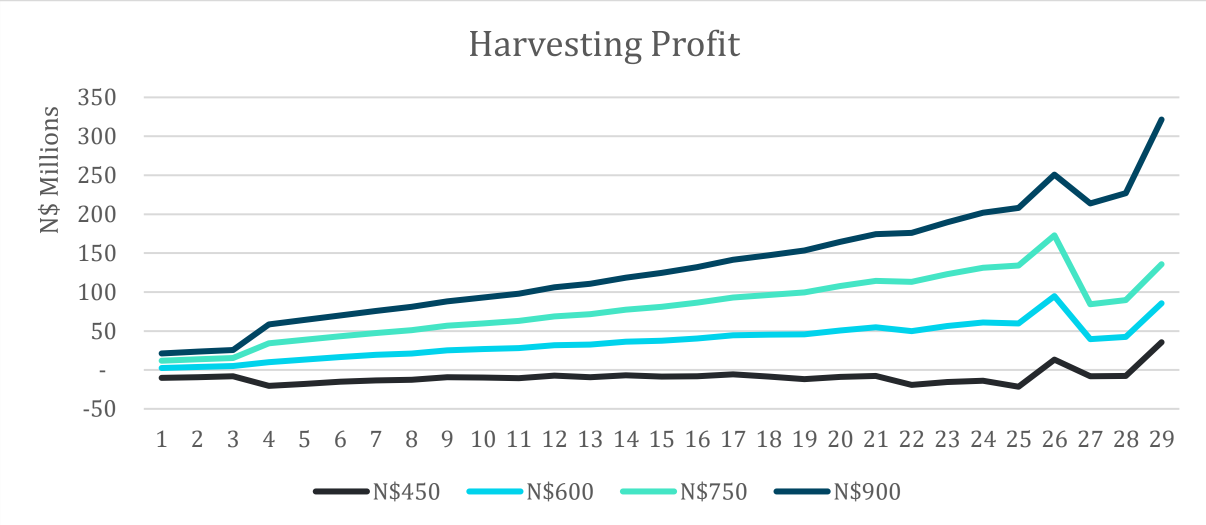
Appendix 9

Scenario:

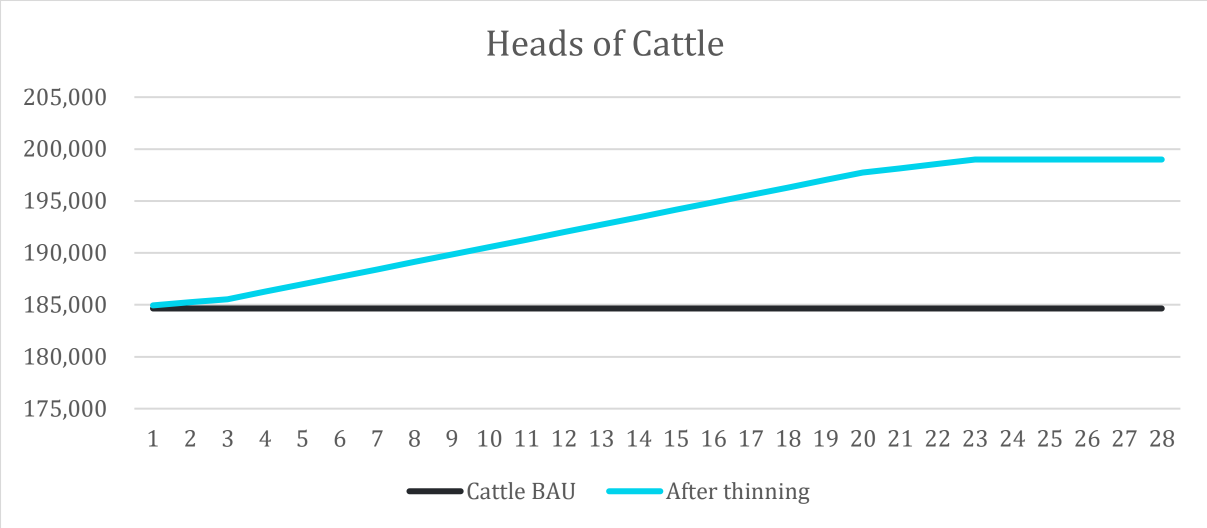
- Power station = 16MWe pilot station, later 20MWe power station
- Capacity Factor = 70%
- Price per kWh installed = USD 3500/kW

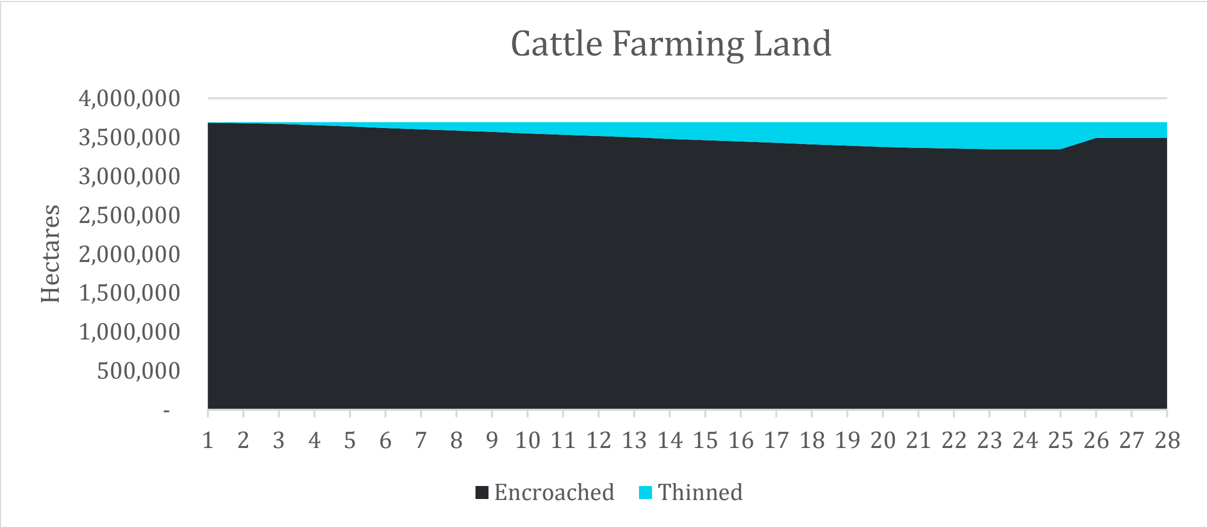


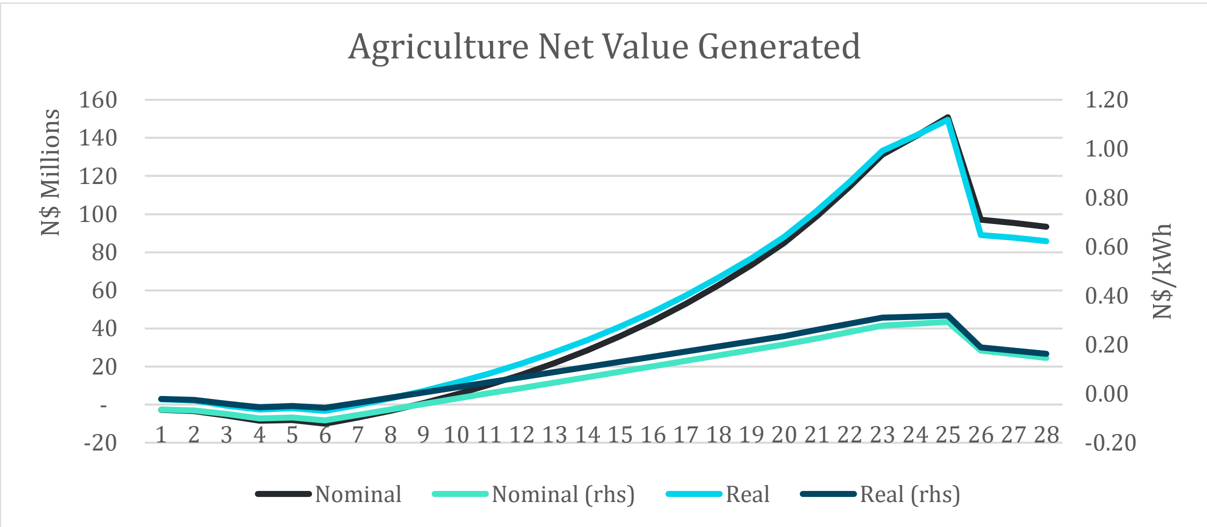
As with all other scenarios, harvesting is profitable for the three higher price points (viz. NAD600/t, NAD750/t, NAD900/t).



The 16MWe power station has an annual fuel requirement of 91,689.8t, resulting in 7,248ha of land being bush thinned. The 20MWe power station has an annual fuel requirement of 128,687t, which is equivalent to 10,173ha being thinned per annum. In all, a total of 435,528ha will be thinned during the operation of the power stations, resulting in 14,347 more heads of cattle.







The summarised supply chain and land-use change emissions over the project's 28 years:

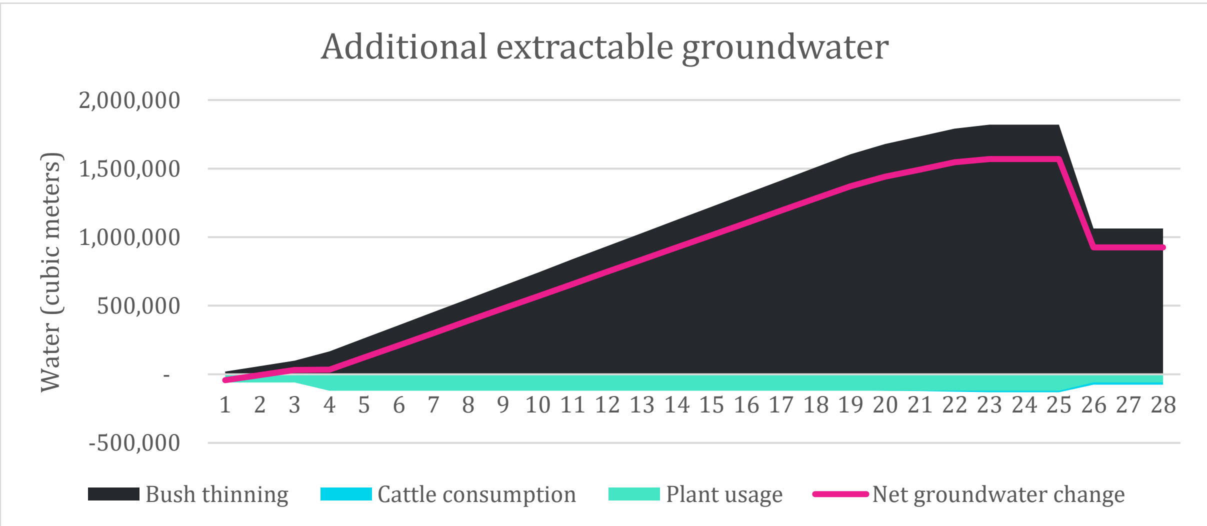
Activity	$kgCO_2e$ over 28 Years	$kgCO_2e$ / kWh
Harvesting	148,883,183	0.05

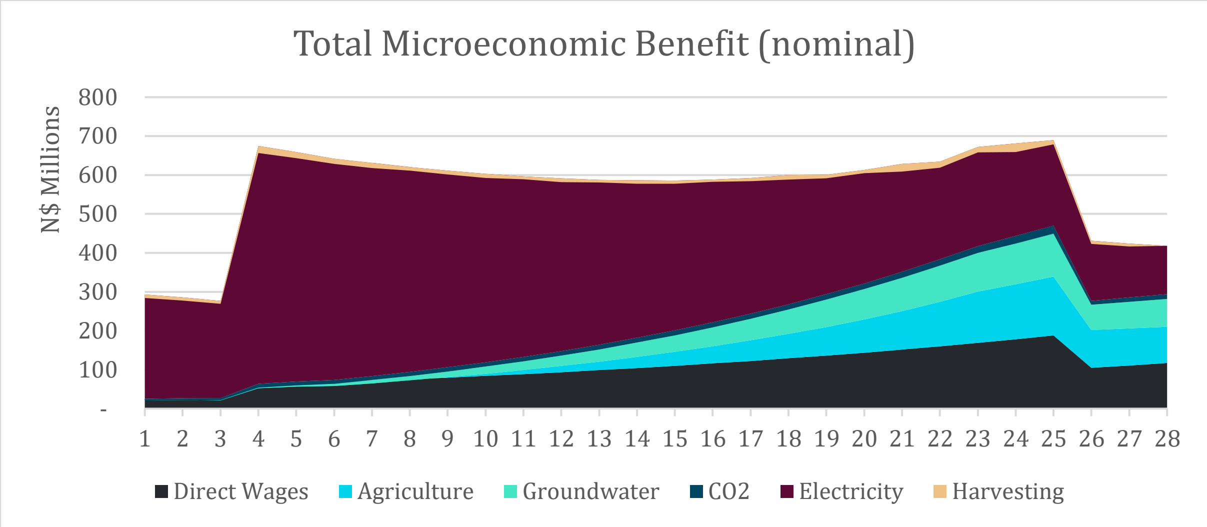
Transport	25,925,881	0.01
Conversion	101,088,000	0.03
Soil Carbon	255,202,057	0.09
Livestock	787,928,410	0.26
Total	**1,319,027,531**	**0.44**

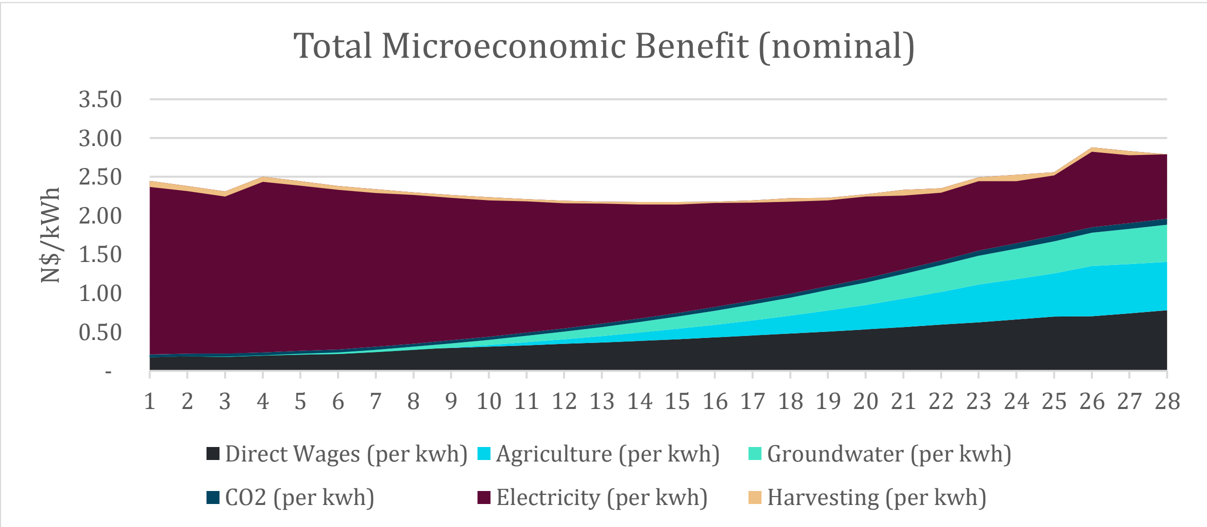
	$kgCO_2e$ over 25 Years			
Grid Emission Factor	**Emitted**	**Displaced**	**Project Net**	**$KgCO_2$ per kWh**
Namibian Grid = 0.4898 (WSP)	1,319,027,531	-3,300,860,160	-1,981,832,629	-0.66
SAPP = 0.9644 (UNFCCC)		-6,499,284,480	-5,180,256,949	-1.73

	Value of Net Emissions at beginning of operational period
Carbon Price	**NIRP NAD85**
NPV NAD	399,877,428.23
NAD/kWh	0.13

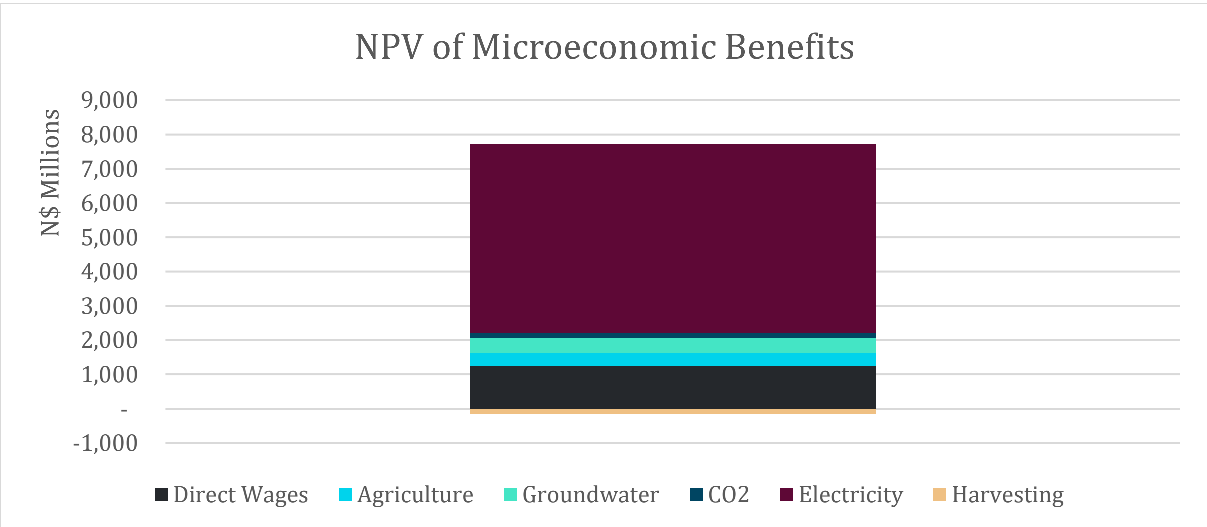
The project will result in a net gain of 23.2 million cubic m^3 of groundwater, assuming regrowth of encroacher bush in Year 20 – which results in a far more conservative final value. The net present value of the additional groundwater is estimated at NAD470.1 million.

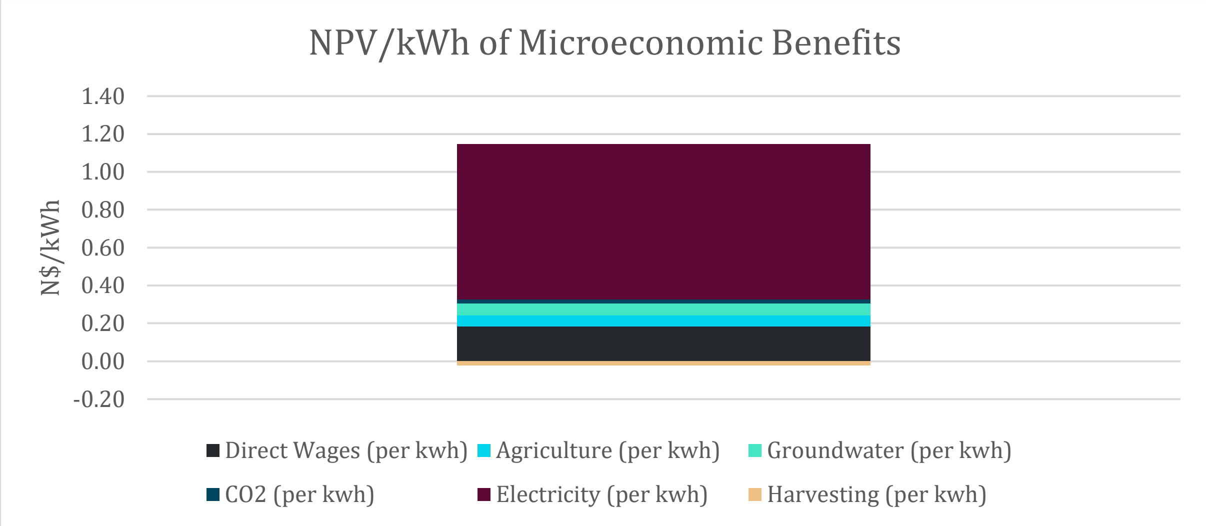


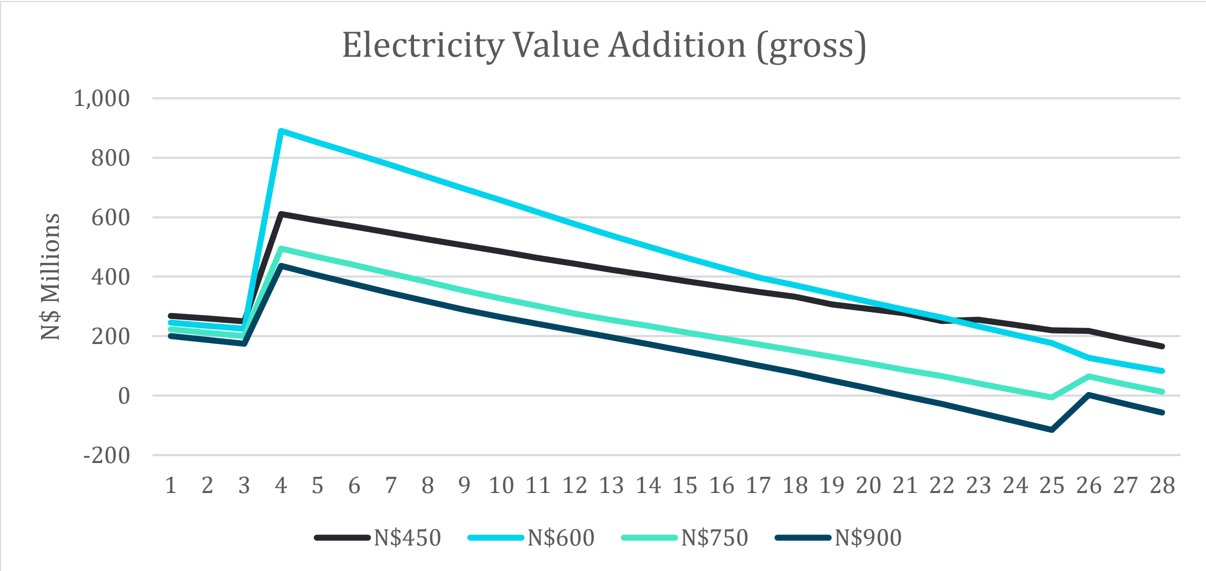


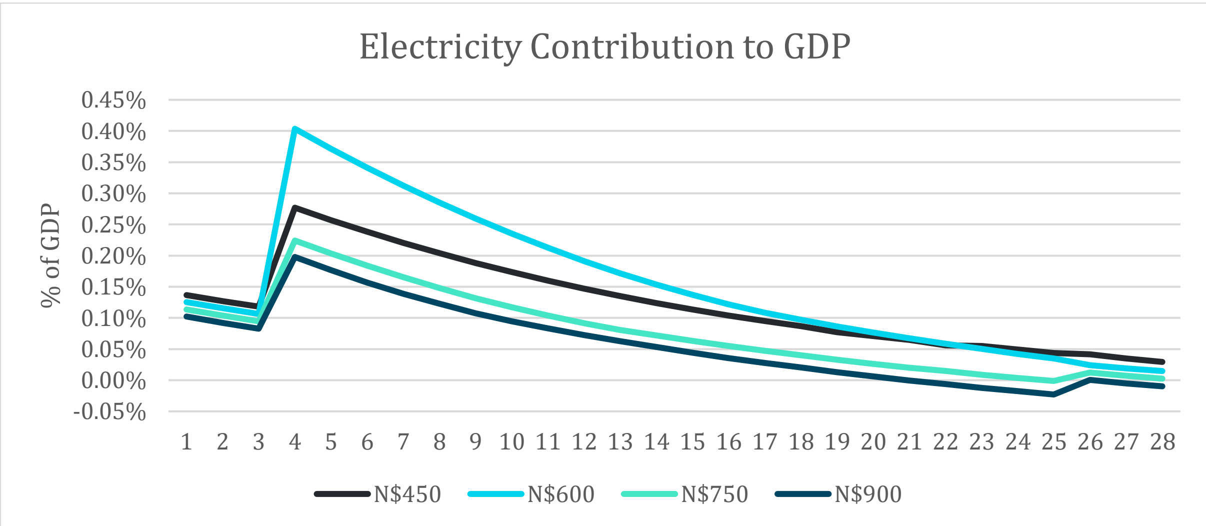


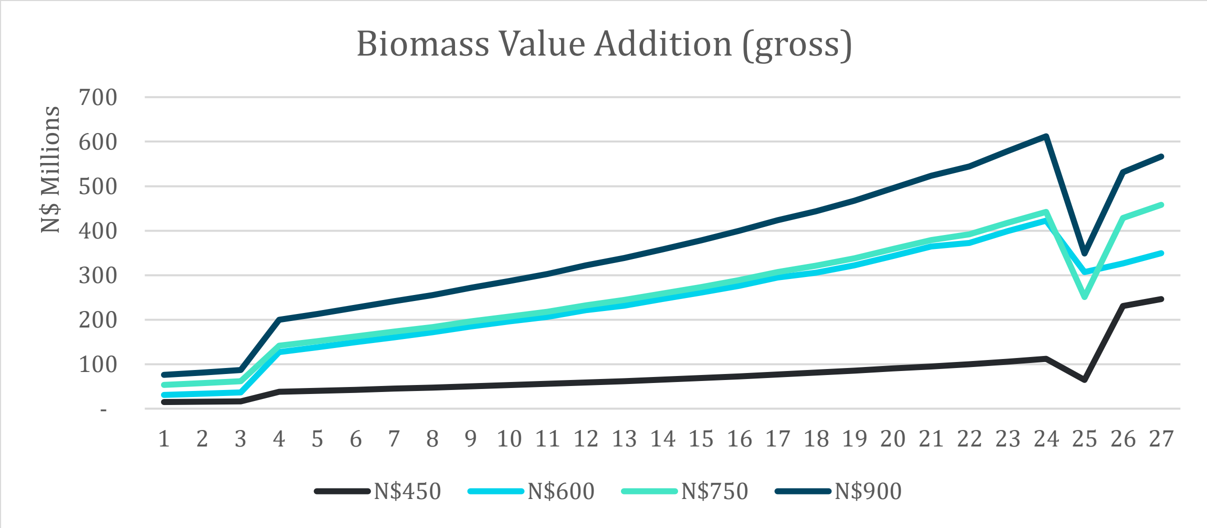
The net present value of total microeconomic benefits is NAD7.6 billion, or NAD1.13/kWh.

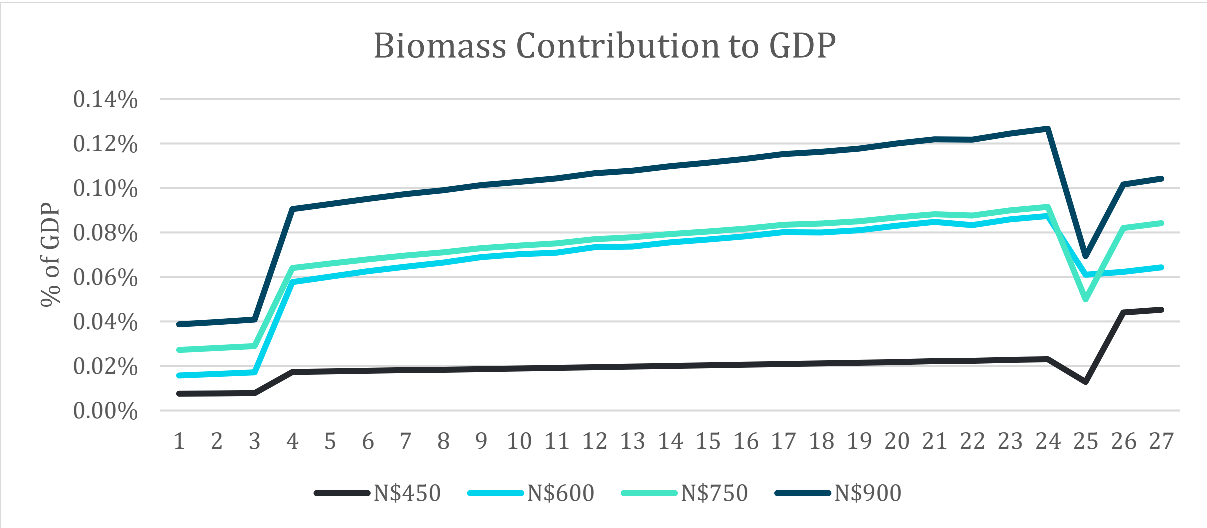


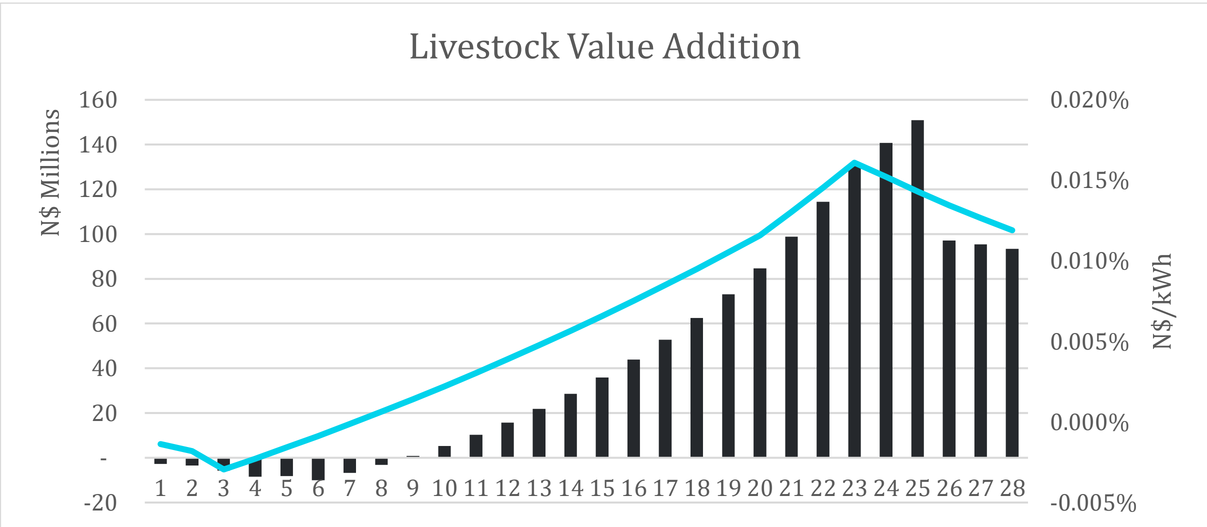

NPV/kWh of Microeconomic Benefits
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
-0.20
N$/kWh
Direct Wages (per kwh)
Agriculture (per kwh)
Groundwater (per kwh)
CO2 (per kwh)
Electricity (per kwh)
Harvesting (per kwh)

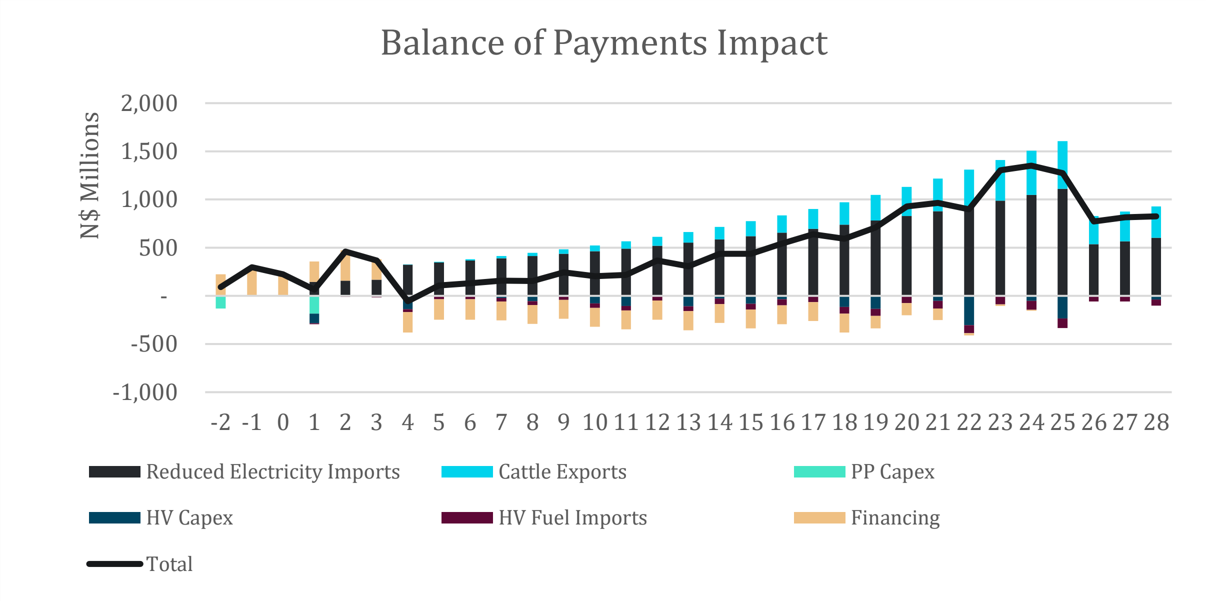

Electricity Value Addition (gross)
1,000
800
600
400
200
0
-200
N$ Millions
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28
N$450
N$600
N$750
N$900

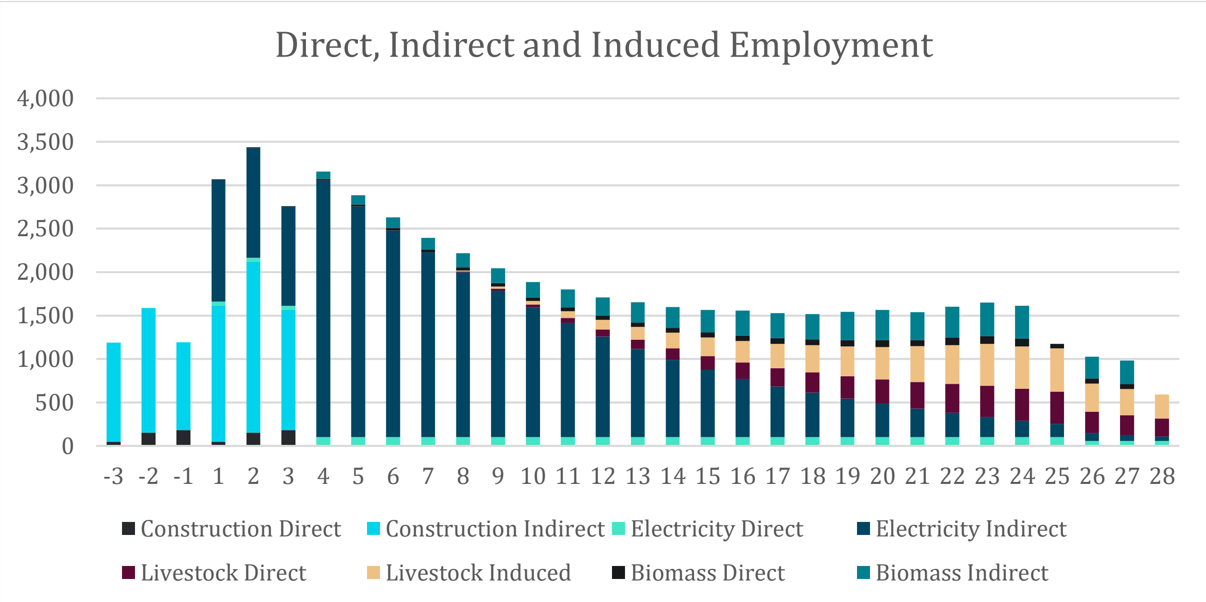

Electricity Contribution to GDP
0.45%
0.40%
0.35%
0.30%
0.25%
0.20%
0.15%
0.10%
0.05%
0.00%
-0.05%
% of GDP
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28
N$450
N$600
N$750
N$900

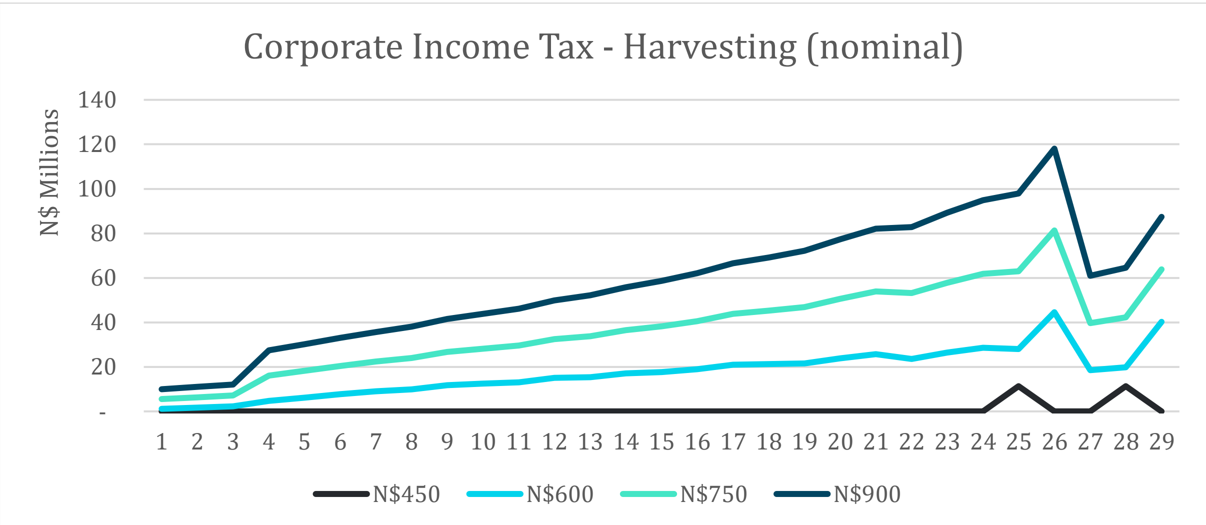

Biomass Value Addition (gross)
N$ Millions
700
600
500
400
300
200
100
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27
N$450
N$600
N$750
N$900

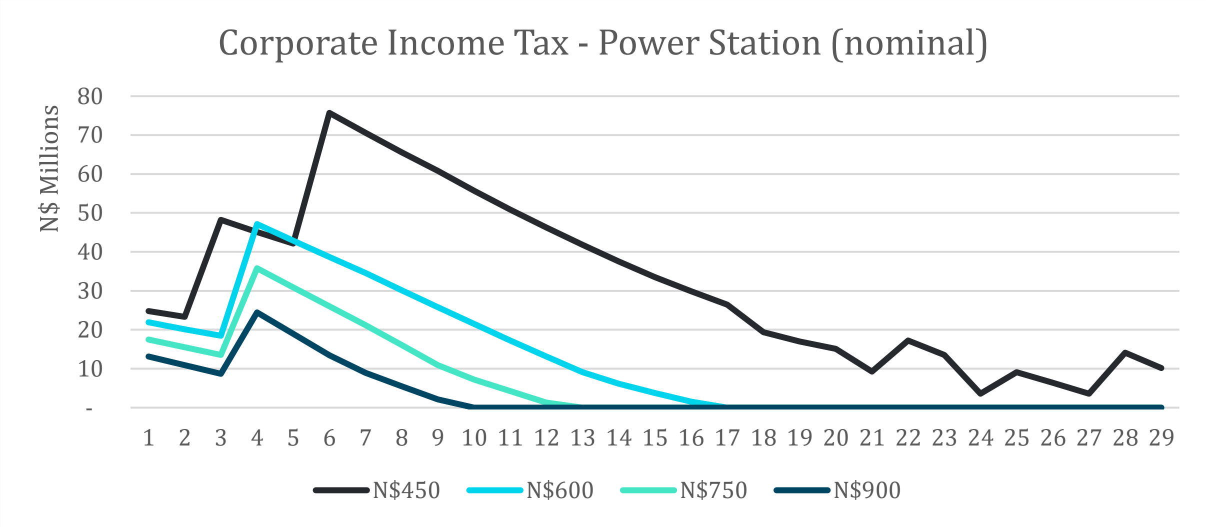

Biomass Contribution to GDP
% of GDP
0.14%
0.12%
0.10%
0.08%
0.06%
0.04%
0.02%
0.00%
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27
N$450
N$600
N$750
N$900


Livestock Value Addition
N$ Millions
160
140
120
100
80
60
40
20
-
-20
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28
0.020%
0.015%
0.010%
0.005%
0.000%
-0.005%
N$/kWh

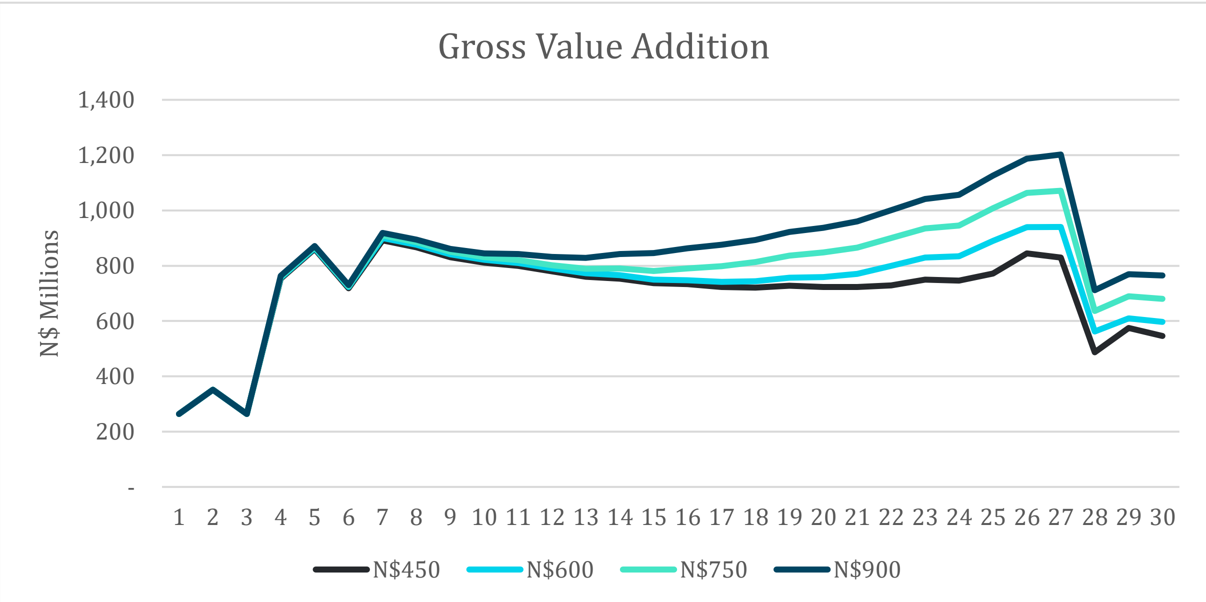

Balance of Payments Impact
N$ Millions
2,000
1,500
1,000
500
-
-500
-1,000
-2 -1 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28
Reduced Electricity Imports
Cattle Exports
PP Capex
HV Capex
HV Fuel Imports
Financing
Total

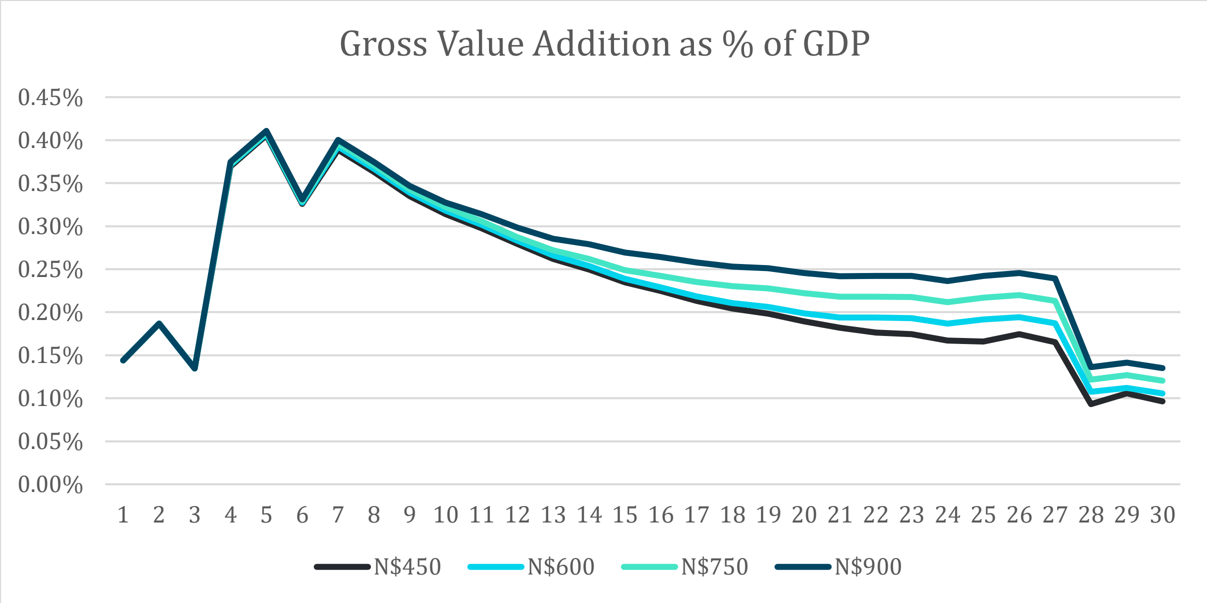

Direct, Indirect and Induced Employment
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
-3 -2 -1 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28
Construction Direct
Construction Indirect
Electricity Direct
Electricity Indirect
Livestock Direct
Livestock Induced
Biomass Direct
Biomass Indirect

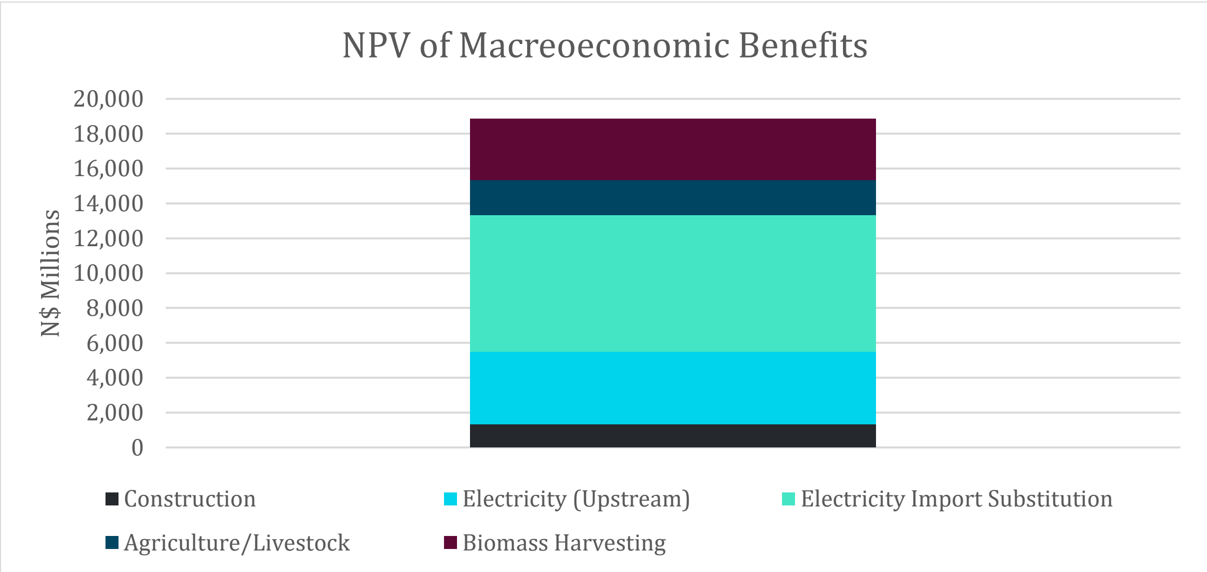

Corporate Income Tax - Harvesting (nominal)
N$ Millions
140
120
100
80
60
40
20
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29
N$450
N$600
N$750
N$900

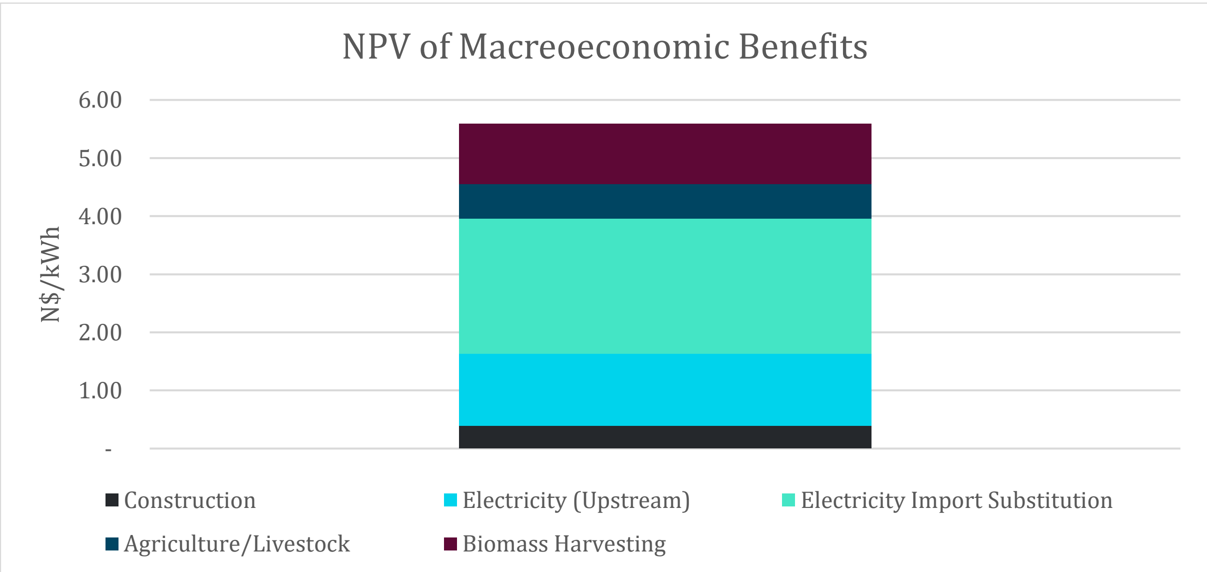


N$ Million	Multiplier	Year					
		1	2	3	4	5	6
Construction Value Addition, Gross		111.85	149.14	111.85	153.60	204.80	153.60
- Downstream	0.21	23.61	31.48	23.61	32.42	43.22	32.42
- Upstream	2.15	240.24	320.31	240.24	329.90	439.86	329.90
Total (Multiplied Value Addition)	2.36	263.84	351.79	263.84	362.31	483.09	362.31
Construction Value Addition to GDP		**0.06%**	**0.08%**	**0.06%**	**0.08%**	**0.11%**	**0.08%**
Multiplied Value Addition to GDP		**0.14%**	**0.19%**	**0.13%**	**0.20%**	**0.26%**	**0.18%**
Value addition/kWh		2.20	2.94	2.20	2.42	3.23	2.42
Value addition/kWh (real)		1.86	2.34	1.66	2.04	2.57	1.82




Gross Value Addition as % of GDP
0.45%
0.40%
0.35%
0.30%
0.25%
0.20%
0.15%
0.10%
0.05%
0.00%
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
N$450
N$600
N$750
N$900


NPV of Macreoeconomic Benefits
N$ Millions
20,000
18,000
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
Construction
Electricity (Upstream)
Electricity Import Substitution
Agriculture/Livestock
Biomass Harvesting


NPV of Macreoeconomic Benefits
N$/kWh
6.00
5.00
4.00
3.00
2.00
1.00
-
Construction
Electricity (Upstream)
Electricity Import Substitution
Agriculture/Livestock
Biomass Harvesting