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BUSH

# Feasibility of Bio-Gasification Technology for Rural Off-Grid Electrification in Namibia

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german cooperation
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giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

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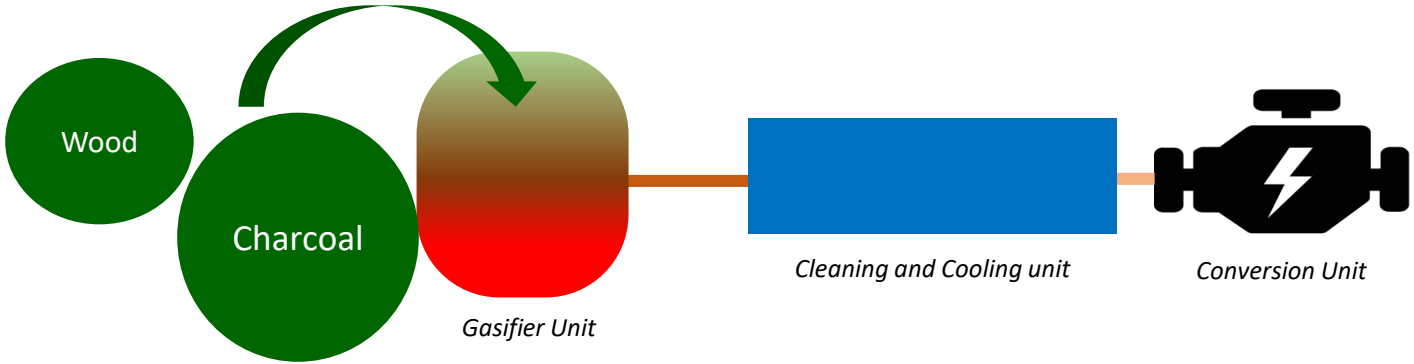
BIOMASS UTILISATION BY SUSTAINABLE HARVEST

# Background

- Bush Encroachment!
- Biomass Gasification is a thermochemical conversion process through which combustible material such as biomass, is subjected to partial combustion in the presence of limited supply of air
- The combustible gas is composed primarily of carbon monoxide (CO), Hydrogen (H2) and methane (CH4) as fuels.
- Ancient Technology:
- Street lights in the 1800s
- 900 000 Cars ran on 1900s

BOTH FROM WOOD GAS

# Background




Biomass Gasification CAN provides clean alternative source of base load electricity

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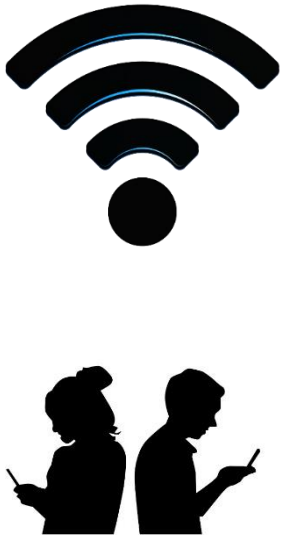


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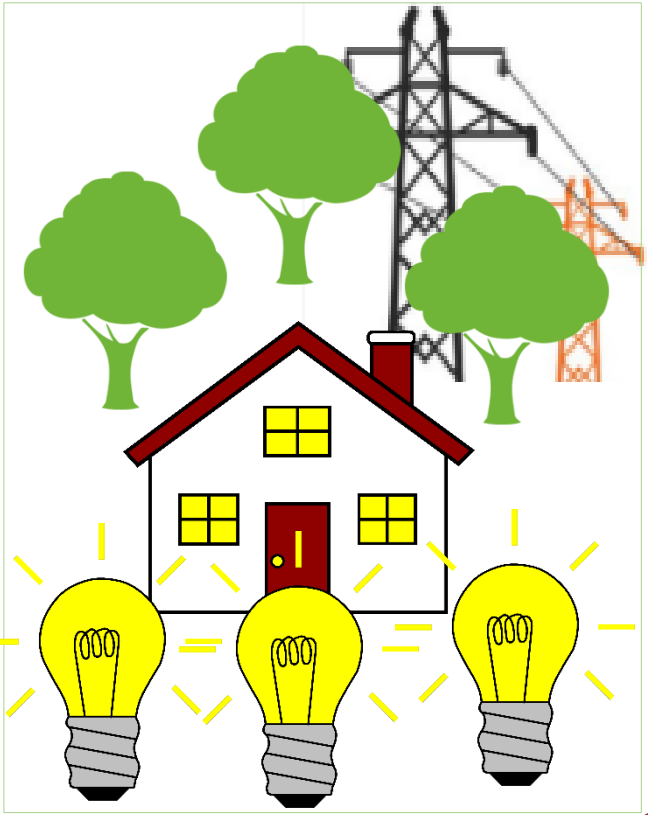

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# Existing Gasification Plant In Namibia

| Name | Location | Manufacturer | Type of Gasifier | Biomass | Rated Output | Status |
|---|---|---|---|---|---|---|
| CBEND | Farm Pierre, Outjo | Ankur Scientific Energy Technologies Pty. Ltd | Downdraft fixed bed | Woodchip / woodblock | 250 kW | Shut down |
| Makarra Briquette | Otjiwarongo | Local | Updraft fixed bed | Charcoal | 42.4 kW | Shut down |
| Makarra Charcoal | Otjiwarongo | Local | Downdraft fixed bed | Charcoal | 44 kW | Running |
| NUST Trailer | NUST, Windhoek | Carbo Consult & Engineering (Pty) Ltd | Updraft fixed bed | Wood / Charcoal | 15 kW | Running |

# Existing Gasification Plant In Namibia: CBEND

- Project costed N$14 000 000.00
- 1.0-1.1 N$/kW Levellised cost
- Created 30 Jobs

| Challenges | Recommendations |
|---|---|
| Wood Preparation Equipment | Reliable and efficient wood preparation methods |
| Heat loss not stored as source of Thermal Energy | Heat loss should be captured for energy application |
| Usage of Refrigeration system(15 kw) | The electricity generated should be in directly fed to off-grid communities rather than the national grid. |
| Only 50kW/250kW was registered | |

- Gasification system on such a large scale are simply not feasible for rural Namibia (Andrew, Richard, Robert, & Wang, 2011).

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# Existing Gasification Plant In Namibia: Makarra Briquette

| No. | Parameter | Unity | Value |
|---|---|---|---|
| 1 | Operational Hours | h | 23 |
| 2 | Operational days | day | 6 |
| 3 | Capital cost (Technology & Installation) | N$ | 25 000.00 |
| 4 | Biomass Cost | N$/t | 1500.00 |
| 5 | Required Biomass | t/yr. | 45 |
| 8 | Diesel cost saved | N$/yr. | 811 200.00 |
| 9 | Total fuel cost | N$/yr. | 448 350.00 |
| 10 | Producer Gas: Diesel Ratio | - | 77:23 |
| 11 | Approx. Biomass Collection Radius | Km | 0.5 |
| 12 | Peak Load | Kw | 20 |

- **Problems: Lack of technical knowledge, maintenance, Instrumentations, Mismanagement of tar, ash**
- **The plant was expanded in April 2019 & is now powered by CENORED and planning to switch to solar power by 2020.**

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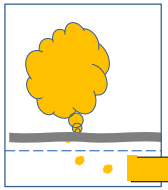
# Existing Gasification Plant In Namibia: Makarra Charcoal

| No. | Parameter | Unity | Value |
|---|---|---|---|
| 1 | Operational Hours | h | 8 |
| 2 | Operational days | day | 5 |
| 3 | Capital cost (Technology & Installation) | N$ | 45 000.00 |
| 4 | Biomass Cost | N$/t | 1500.00 |
| 5 | Required Biomass | t/yr. | 4 |
| 10 | Producer Gas: Diesel Ratio | - | 25:85 |
| 11 | Approx. Biomass Collection Radius | Km | 0.05 |

- Lack of constant monitoring at the grate, Frequent shaking
- **Poor gas filtering system : Mattress Foam**
- **Lack of Instrumentation**



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# Existing Gasification Plant In Namibia: NUST TRAILER

- ¼ systems to run on Petrol
- On average, petrol engine running on combustible gas produces 0.55-0.75 kWh of energy from 1kg of biomass (Rajvanshi, 1986).
- Excellent gas clean-up systems (Cyclone, wet charcoal & wood shaving).
- Still being renovated for experimental purposes

# Feasibility for Rural Off-grid Electrification

**"The barriers facing gasification are meanwhile too significant and wide-ranging for research to make a significant difference to uptake. Gasification-related research is therefore not deemed worth supporting" (LTS, 2017)**

**Barriers**

- Feedstock quality and availability Constraint
- Technology Limitation
- Lack of Viable Business Model
- Limited Operator technical capacity
- Poor access to manufacturer support and spare parts

- Feedstock ash Content
- Different Feedstocks

  Kernel shell exudes acidic oil
- Lack of instrumentations
- International manufacturer
- Installing Capacity>100 kW

## Disagree!

**Abundant Biomass**

**Training**

**Local Manufacturers**

- Fulfils HPP-to increase the provision of rural electrification by 50%.
- Gasification Awareness

Fuel Wood works well with gasifiers (Dimpl,2011)

Feasible In Namibia

# Feasibility for Rural Off-grid Electrification

Food and Agriculture Organization of the United Nations

## RAPID APPRAISAL TOOL FOR RURAL ELECTRIFICATION – GASIFICATION

Plant Maintenance Once a week 312 days/yr.
Instrumentation
Downdraft gasifier
70% Syngas
Engine deration 30%

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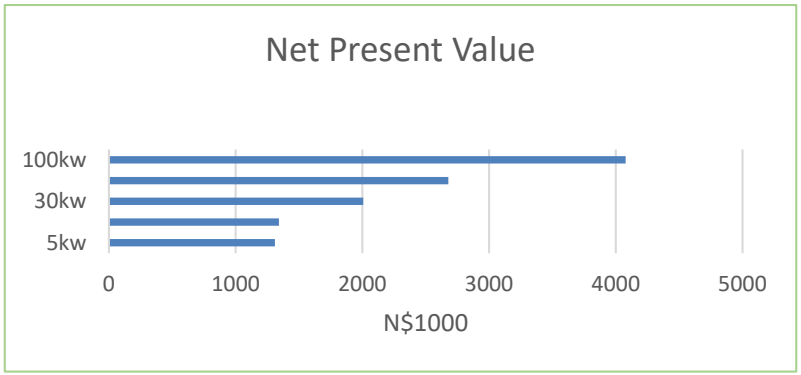
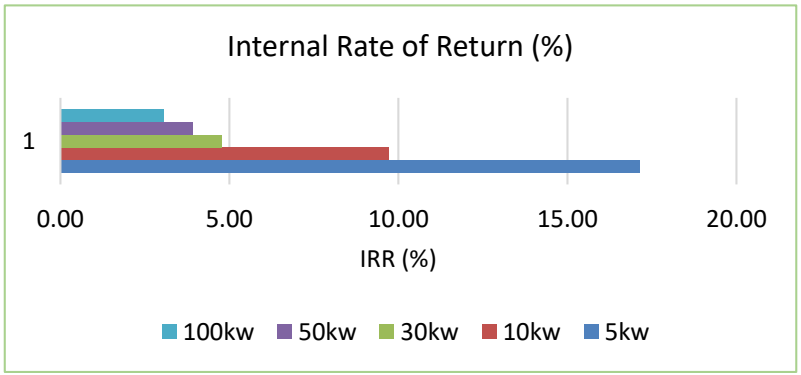
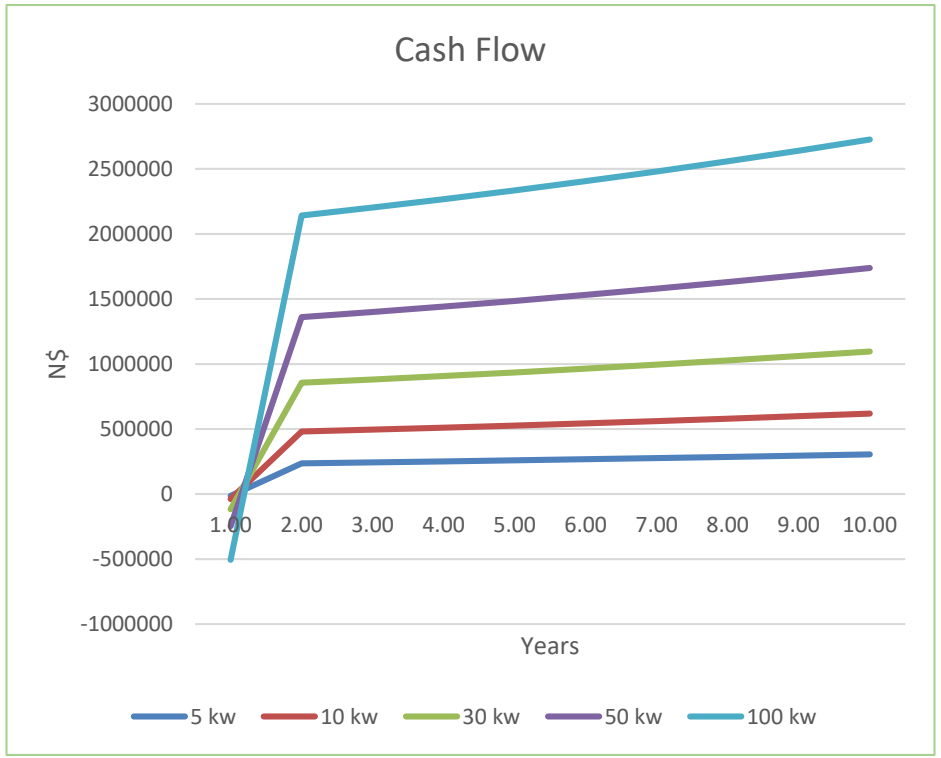
# Feasibility for Rural Off-grid Electrification: Wood feedstock



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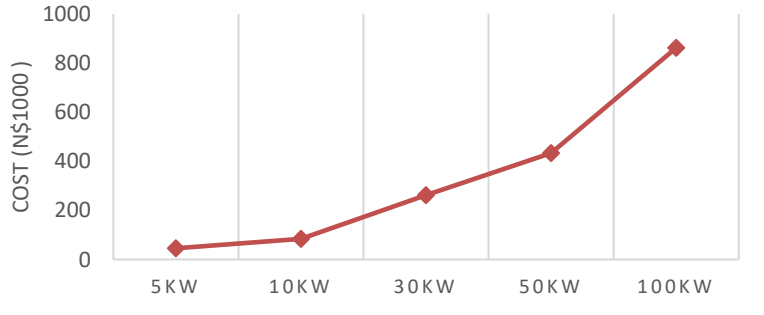


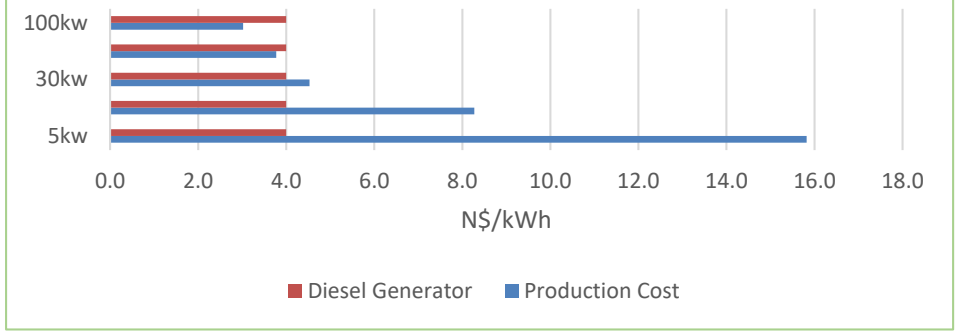


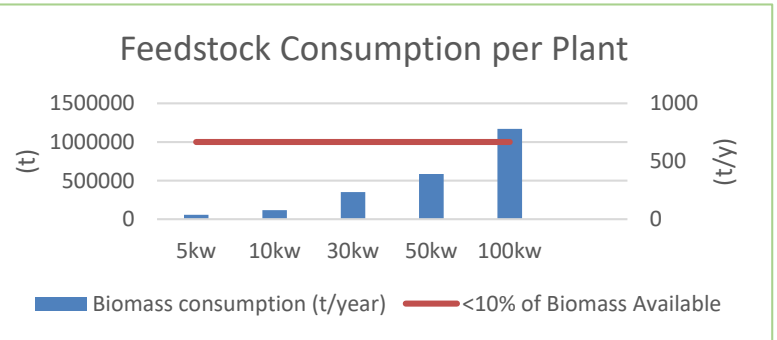


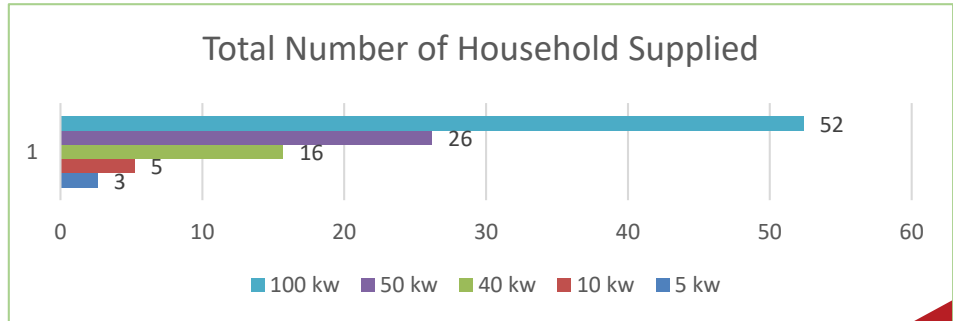

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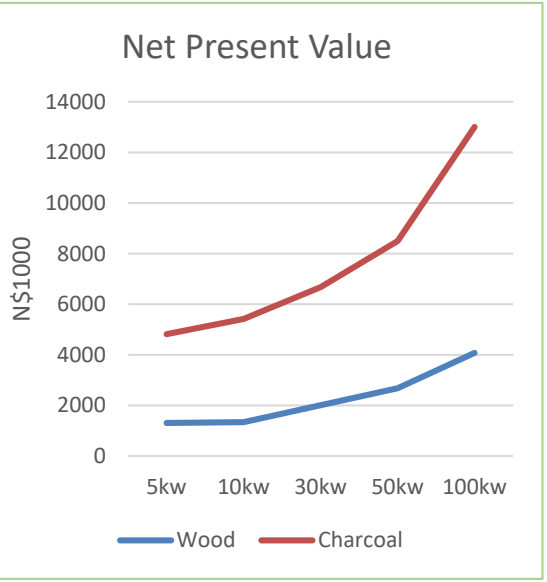
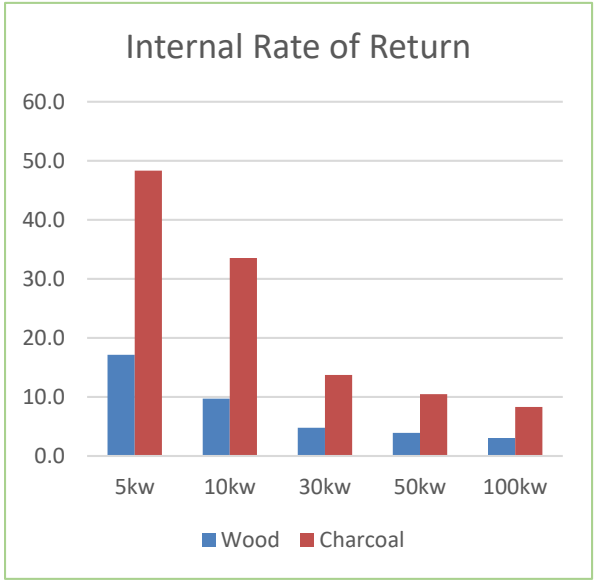
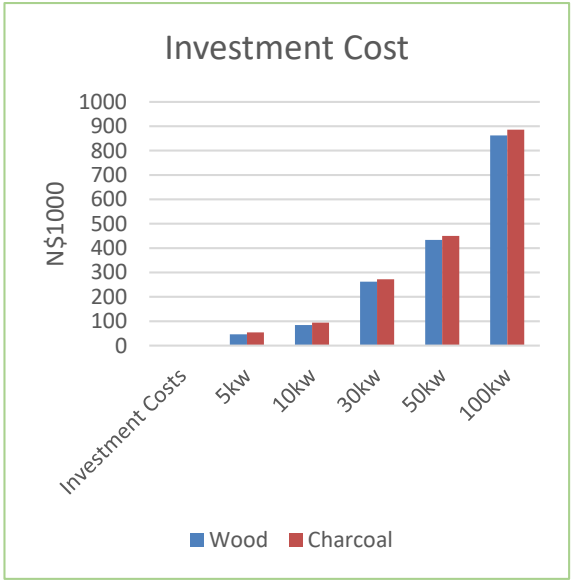
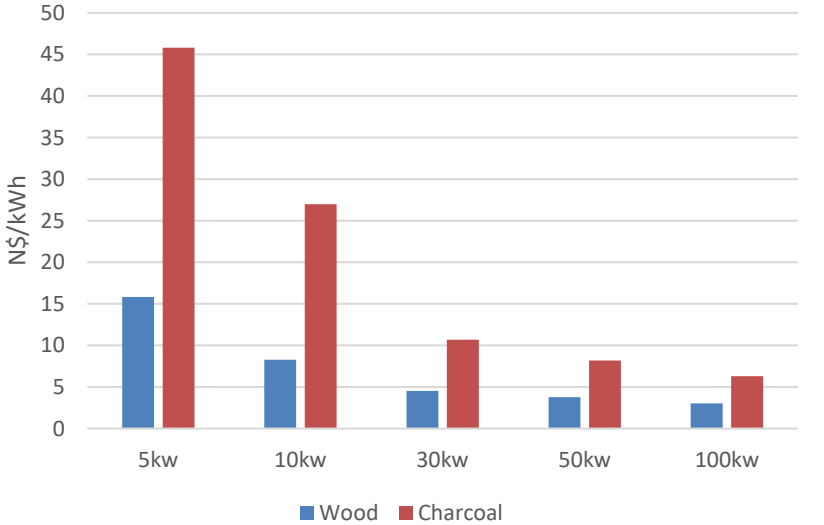
# Feasibility for Rural Off-grid Electrification: Charcoal Vs. Wood

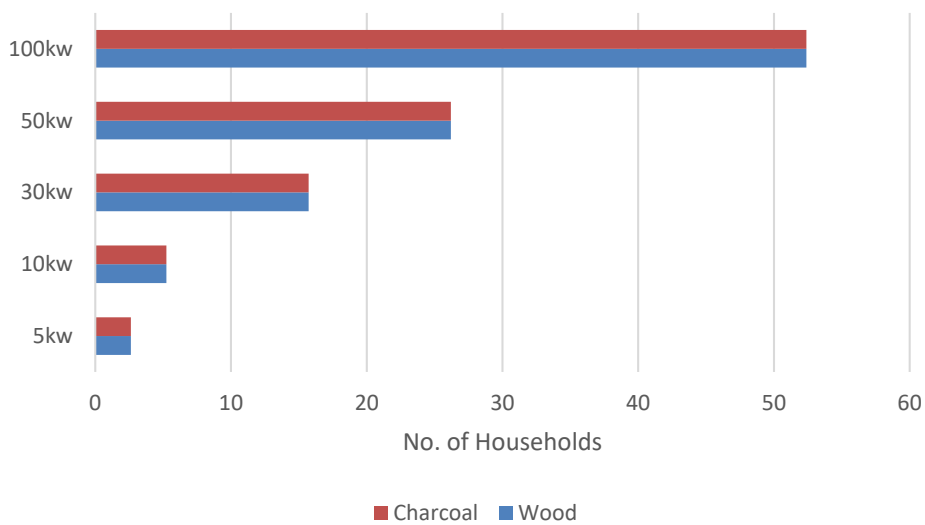


# Feasibility for Rural Off-grid Electrification: Charcoal Vs. Wood



# Feasibility for Rural Off-grid Electrification

Marula Kernel

- Drought-resistant tree that is widely distributed in sub-Saharan tropical Africa.
- Mostly found in the northern part of Namibia.
- Dry kernels are used as source of fire as well as fertilizer.
- 80 000 households, 5 estimated Trees.

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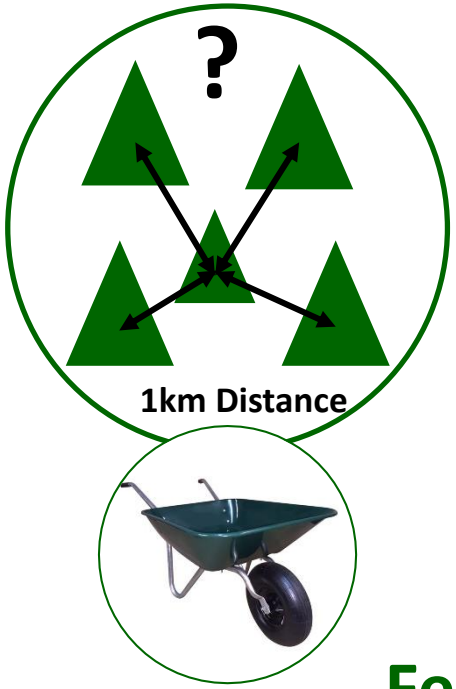
# Feasibility for Rural Off-grid Electrification




| | 5kw | 10kw | 30kw | 50kw | 100kw |
|---|---|---|---|---|---|
| Production Cost (N$/kwh) | 15.82 | 8.27 | 4.53 | 3.77 | 3.02 |
| Investment Costs (N$1000) | 45.98 | 84.28 | 262.17 | 433.29 | 862.08 |
| Net Present Value (N$1000) | 1309.4 | 1341.64 | 2007.22 | 2678.23 | 4076.81 |
| Internal rate of Return(%) | 17.16 | 9.72 | 4.79 | 3.91 | 3.05 |
| Biomass consumption (t/year) | 39.04 | 78.07 | 234.22 | 390.36 | 780.72 |
| Biomass Available (t) | 15.00 | 45.00 | 195.00 | 300.00 | 600.00 |
| No Of Households | 1 | 3 | 13 | 20 | 40 |

**Feasible for Small scale <10kW**

- Distribution Cost
- Transportation Cost

# Feasibility for Rural Off-grid Electrification

- For as long us the plant is maintained, monitored & understood locally, small scale plant will always be feasible.
- ELECTRICITY IS THE PASSWORD!
- **Establishment of Policies to effortlessly influence the integration of biomass gasification with other existing renewable technology.**

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**Feasibility of Bio-Gasification Technology for Rural Off-Grid Electrification in Namibia**

# Thank You!

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