Energy Content & Combustion Behaviour of Loose Biomass Available in Limpopo

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BACKGROUND

- Biomass is major source of energy for rural communities
- **80% of energy needs** in Sub-Saharan Africa supplied by round wood
- Unfortunately this leads to **0.7% annual deforestation**

- Millions of **tonnes of loose biomass** produced annually
  - Agricultural waste
  - Forestry residual

- Destroyed in perennial veld fires
- Not usable due to **low energy density**
- Need to find way to **harness this energy**

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RESEARCH AIMS

- ✓ To investigate the **energy content, combustion behaviour & emissions** of loose biomass
- ✓ Identify suitable **briquetting candidates**
- ✓ Investigate the energy content, combustion behaviour & emissions of **briquetted biomass**

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MOTIVATION

- Reduce challenges of **deforestation**
- Reduce reliance on **round wood** as a source of energy
- Increase use of **agricultural** and **forestry residues**
- Improve **combustion** and **emissions** behaviour
- Success will improve the **availability, reliability** of sustainable energy sources especially in off grid communities.

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EXPERIMENTAL PROGRAM

General Procedure

1) Specimens collection
2) Shredding
3) Weighing
4) Density measurement
5) Drying
6) Moisture content measurement
7) Calorific values tests
8) Combustion behaviour tests

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EXPERIMENTAL PROGRAM

Combustion Behaviour Measurements

- Tests conducted at SeTar
- Used Imbawula Stove
- Monitored parameters include:
  - Exhaust temperatures
  - Exhaust gases
  - Mass decay rate

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RESULTS

Dry Sample Calorific Values

LOOSE BIOMASS	CV (J/kg)
Sugar Cane Leaves	16.38
Mopani Bark	16.37
Mopani Leaves	**18.81**
Ground Nut Shells	**20.31**
Ground Nut Leaves and Stem	17.23
Yellow Thatching Grass	16.73
Coconut Shell	18.31
Eucalyptus Saw Dust	**19.97**
Cow Dung	12.87
Mealie Cobs	17.5
Maize Leaves	15.58
Maize Stalk	14.62
Coconut Skin	16.55
Walnut Shells	**18.58**
Sweet Sorghum Seeds	16

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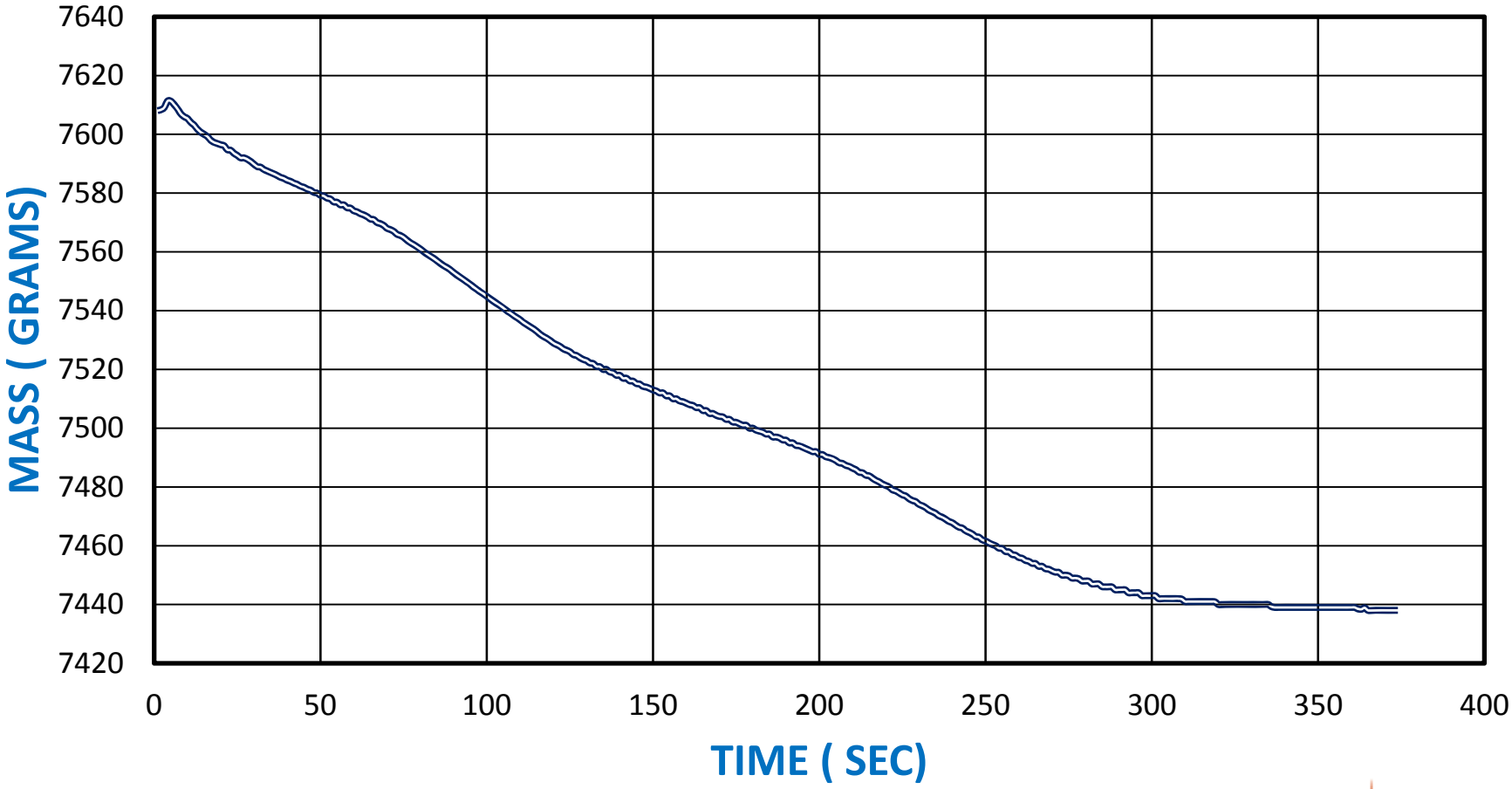
RESULTS

Combustion Performance: Cow Dung



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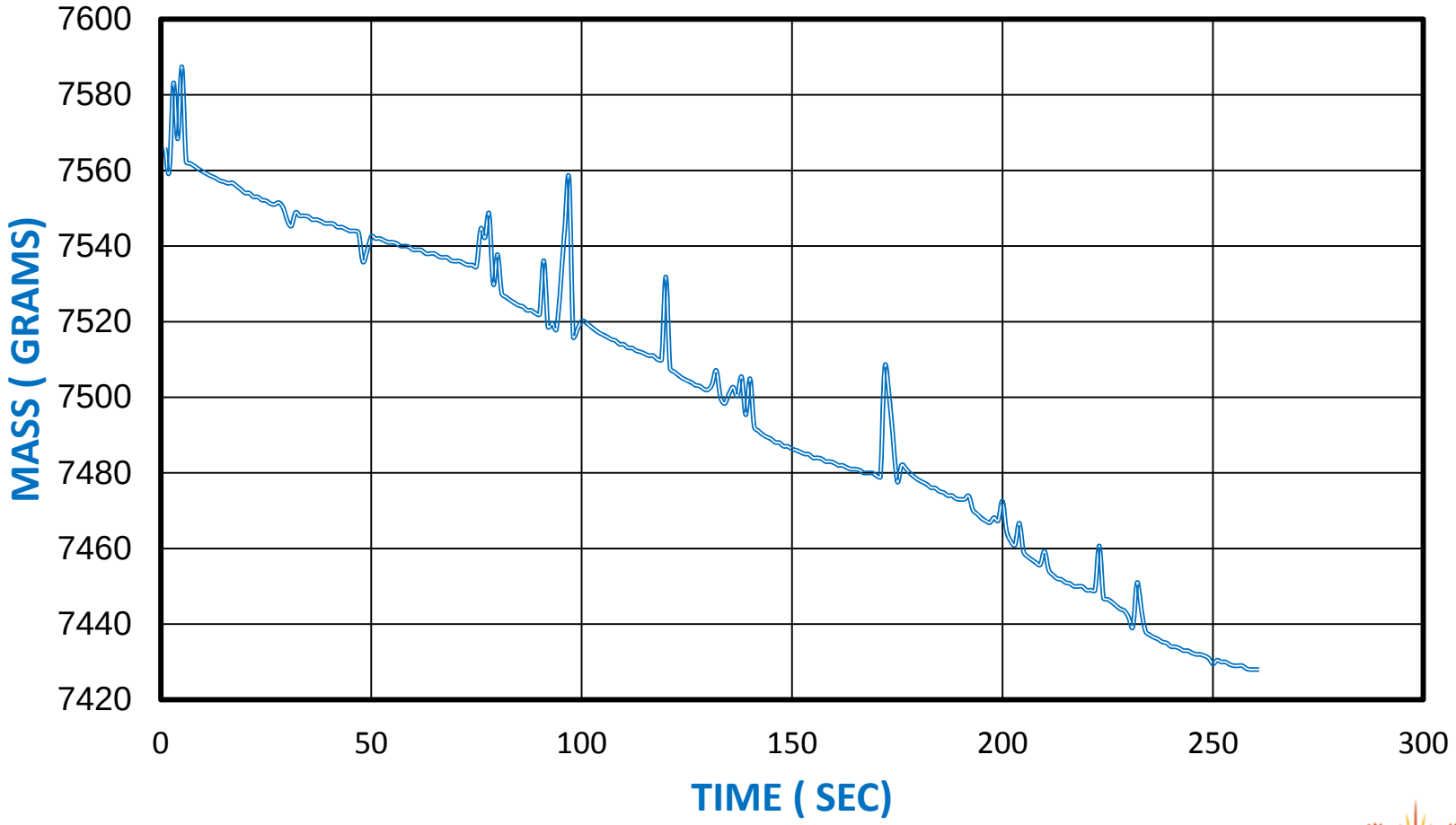
RESULTS

Combustion Performance: Eucalyptus



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RESULTS

Combustion Performance

BIOMASS PRODUCT	DENSITY (kg/m^3)	MOISTURE CONT. (%)	TIME (sec)	RATE (g/sec)
Sugar Cane leaves	0.017	19.2	89	2.44
Mopani Barks	0.055	14.8	72	2.71
Mopani Leaves	0.045	10.7	72	2.71
Ground Nut Shell	0.018	3.3	305	2.68
Ground Nut Leaves and Stem	0.062	3.3	84	3.3
Yellow Thatching Grass	**0.023**	**2**	**129**	**1.51**
Coconut Shell & Skin	0.075	10.7	126	2.43
Eucalypthus Saw Dust	**0.977**	**6.9**	**254**	**0.54**
Cow Dung	**0.038**	**10.7**	**316**	**0.59**
Mealie Cob	0.14	10.7	112	3.19
Mealie Leaves	**0.015**	**6.9**	**105**	**0.71**
Maize Stalk	0.2	6.9	93	2.8

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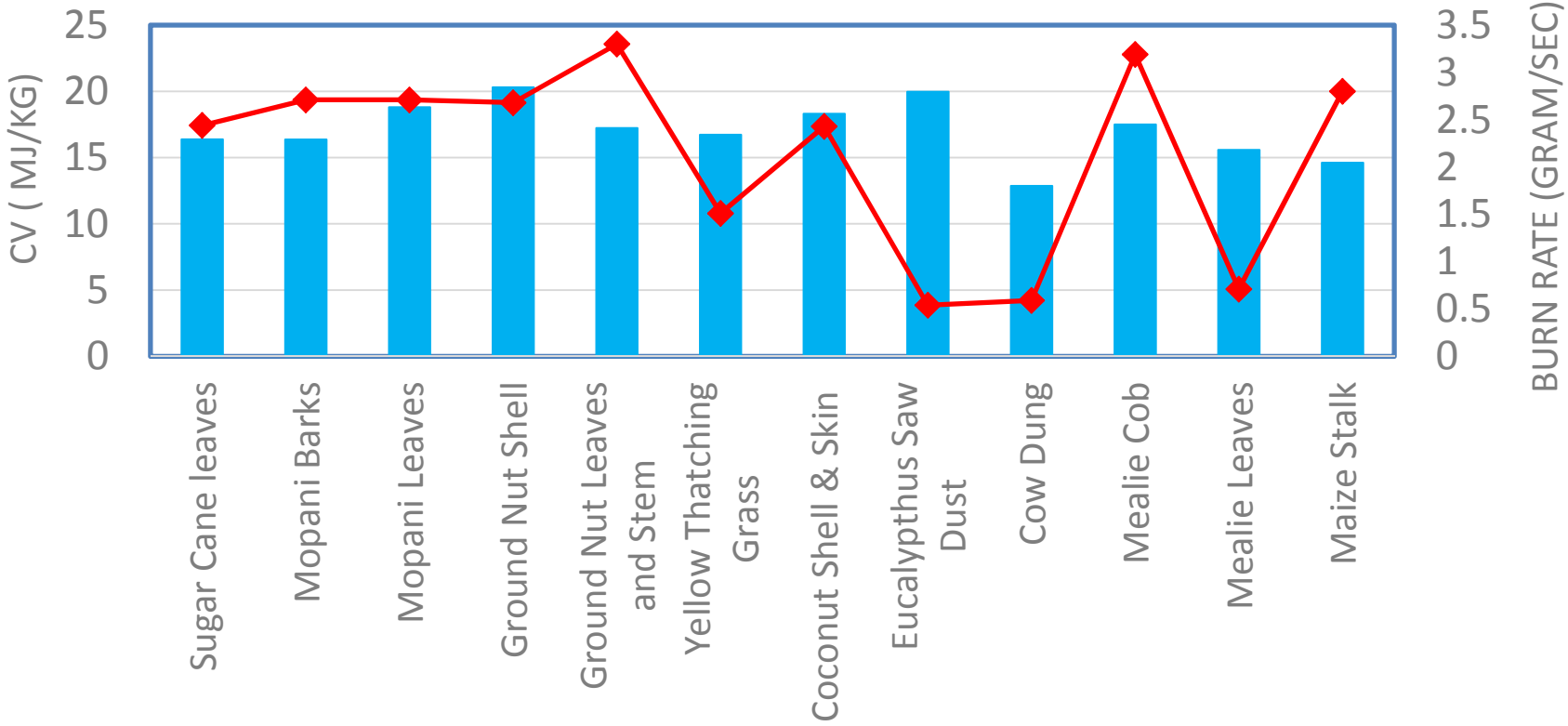
RESULTS

Calorific Value & Burn Rate



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RESULTS

Selecting Briquetting Candidates

Good briquetting candidates require:

1. High calorific value (energy content)
2. Low density for compaction
3. Low burn rate for cooking

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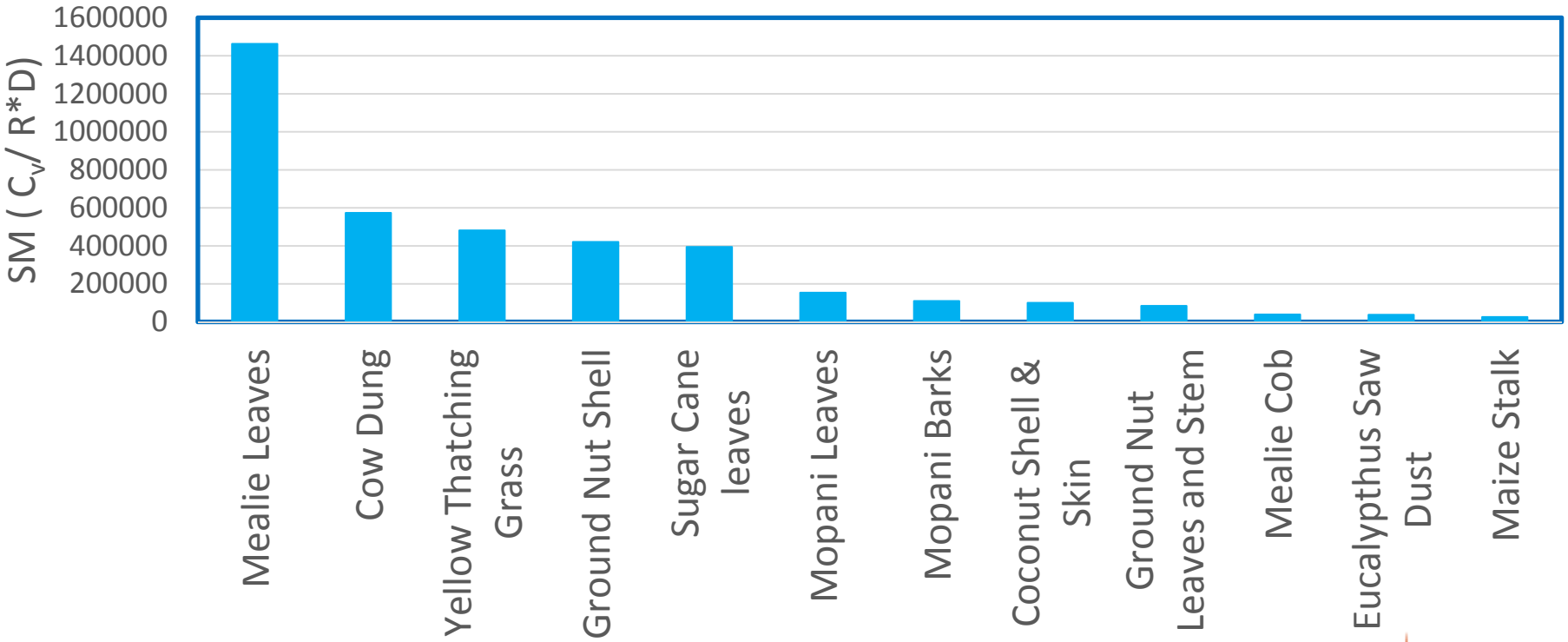
RESULTS

Selecting Briquetting Candidates

$$\textbf{Selection metric} = \frac{Calorific\ Value}{Burn\ Rate \times Density}$$



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CONCLUSIONS

- Performance of the selected loose biomass was characterised based on **energy content, density, moisture content and burning rate**
- A special selection metric was used to select potential candidate materials for briquetting in that region
- The final choice of brequetting materials can also be influenced by other factors such as **availability of materials, briquetting process** chosen

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CONCLUSIONS

- **Mealie leaves, Cow dung, yellow thatching grass, sugar cane leaves and maize leaves** demonstrated good potential based on the selection metric
- Materials such as **mopani leaves and eucalyptus saw dust** can be considered based on availability

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GOING FORWARD

1. Further work will be required to produce the biomass briquettes using the **selected stock materials** and test their performance
2. **Health impact assement** from emmisions and the characterisation of the gases emitted by all potential loose biomass materials must be investigated to ensure that they are safe to use

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THANK YOU

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