Renewable Energy generation
Generating potential- Biomass

Approaches

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Data for crop and forestry production, animal livestock and urban human population can be collated from various government websites and other sources.

The ***raw/ gross energy potential*** of each waste stream can be calculated using various equations.

FAO. Food & Agricultural Organisation to the UN (FAOSTAT). 2021. Available online: http://www.fao.org/faostat/en/#data/FO (accessed on 5 January 2021).

IBRD-IDA. Urban Population Total. The World Bank Group—DataBank. 2021. Available online:

https://data.worldbank.org/indicator/SP.URB.TOTL?locations=CG-TZ

Examples

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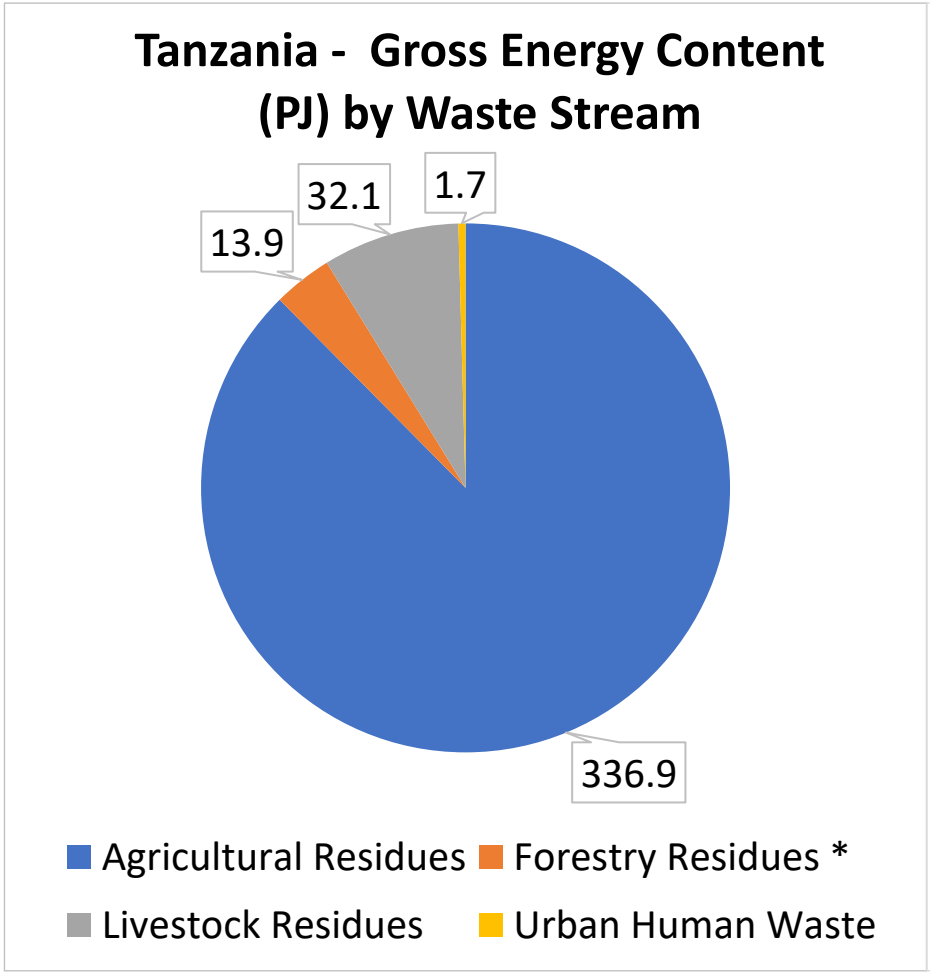

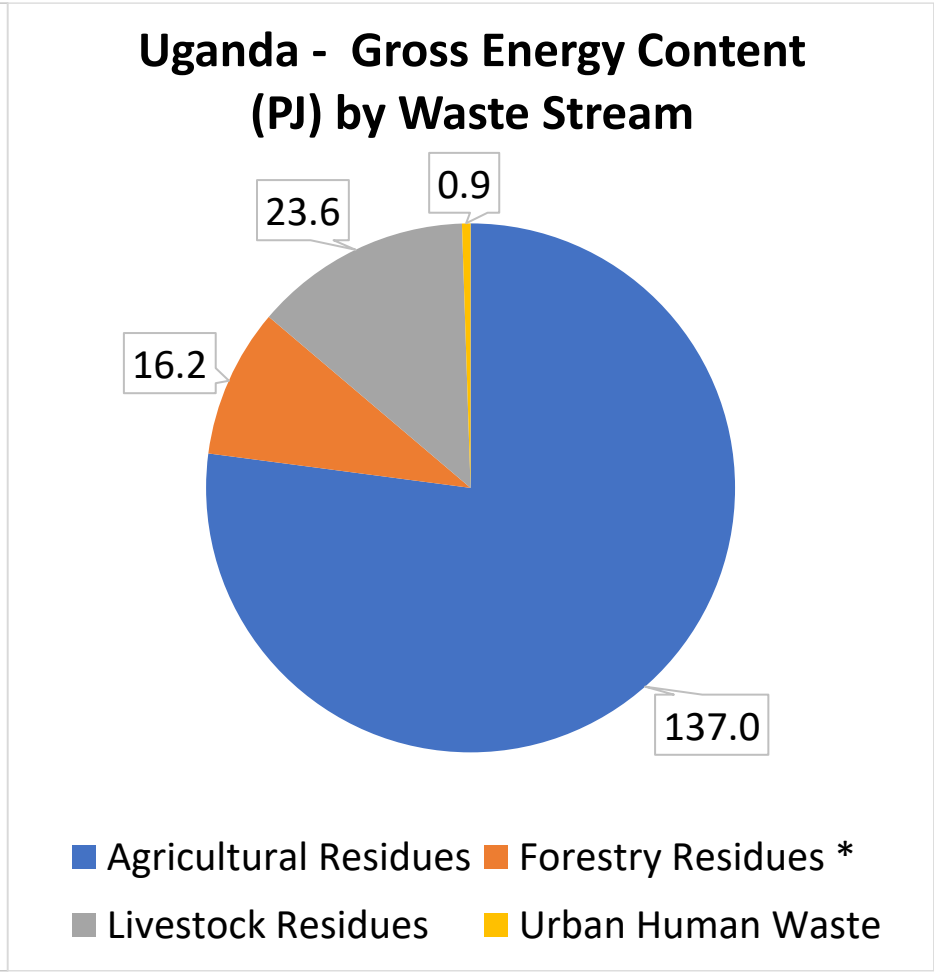

Gross energy potential (EP) Agricultural residues

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1. $ARG = \sum (RPR \times AH)$

1. $EP_{Residue} = ARG \times (SAF + EUF) \times LHV_{Residue}$

ARG = Total available DRY agricultural residues (t/yr) .
AH = Annual crop production (t/yr).
RPR = Residue-to-product ratio.
$EP_{Residue}$ = Total Energy potential (J/t).
SAF = Surplus availability factor
EUF = Energy use factor
SAF + EUF = Fractional availability
$LHV_{Residue}$ = Lower Heating Value of Biomass

Bhattacharya, S.C.A.S.; Runqing, P.; Somashekar, H.; Racelis, H.I.; Rathnasiri, D.A.; Yingyuad, P.G. An assessment of the potential for non-plantation biomass resources in selected Asian countries for 2010. *Biomass Bioenergy* **2005**, *29*, 153–166.

Gross energy potential (EP)
Forestry residues

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$$EP = PR \times FA \times BD \times LHV_{daf}$$

PR = Annual Production of industrial roundwood & plywood (m^3).
BD = Basic density (oven dried weight/ green volume, kg/m^3).
LHV_{daf} = Lower Heating Value (dry ash free) (MJ/kg).
FA = Fractional availability factor.
EP = Total Gross Energy potential.

Simonyan, K.J.; Fasina, O. Biomass resources and bioenergy potentials in Nigeria. *Afr. J. Agric. Res.* **2013**, *8*, 4975–4989.

Gross energy potential (EP) Livestock residues

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1. $DMR = DM \times NA \times FR \times 365.$
2. $ABP_{Manure} = \sum DMR \times VSDM \times BY.$
3. $EP_{Manure} = ABP_{Manure} \times LHV_{Biogas}.$

DMR = Amount of dry matter recovered (kg DM/yr).

DM = Dry matter (kg/head/day)

NA = Number of animals

FR = Fraction of animal manure recovered.

ABP_{Manure} = Biogas from manure (Nm^3/yr).

LHV_{Biogas} = Lower Heating Value of Biogas.

VSDM = Fraction of volatile solids in DM (kg VS. kg^{-1} DM).

BY = Biogas Yield (Nm^3 kg^{-1} VS).

EP_{Manure} = Total Gross Energy potential (J).

Bhattacharya, S.C.A.S.; Runqing, P.; Somashekar, H.; Racelis, H.I.; Rathnasiri, D.A.; Yingyuad, P.G. An assessment of the potential for non-plantation biomass resources in selected Asian countries for 2010. *Biomass Bioenergy* **2005**, *29*, 153–166.

Gross energy potential (EP) Urban Human waste

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1. $DMR = UP \times DM \times 365$
2. $ABP_{UHW} = \sum DMR \times VSDM \times BY.$
3. $EP_{UHW} = ABP_{UHW} \times LHV_{Biogas}.$

UP = Urban human population in 2018
DM = Dry matter (kg/head/day)
DMR = Total dry matter recovered (kg/yr).
ABP_{UHW} = Amount of biogas (Nm^3/yr)
VSDM = Fraction of volatile solids in dry matter (kg VS. kg^{-1} DM).
BY = Biogas Yield (Nm^3 kg^{-1} VS).
LHV_{Biogas} = Lower Heating Value of Biogas.
EP_{UHW} = Total Gross Energy potential.

Approaches

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The ***net electrical generating potential*** for each stream can be calculated.

Overall efficiencies can be assumed based on whether electricity generated from the different feedstocks is fed into a national GRID (25% loss) or fed into a Micro GRID (10% Losses) .

Example

- Energy generated from agricultural, forestry and urban human waste residues could be fed into a national grid, hence national transmission and distribution losses are accounted for. [1].

- Energy produced from livestock waste via AD could be fed into a local grid, hence mini grid losses were accounted for [2].

1. IEA. IEA Atlas of Energy 2021. Total Electricity Generation in TWh by Country. Available online: https://www.iea.org/data-and-statistics/data-tables?country=TANZANIA&energy=Electricity&year=2018 (accessed on 19 January 2021).
2. Hirsch, A.; Yael, P.; Joseph, G. Microgrids: A review of technologies, key drivers, and outstanding issues. *Renew. Sustain. Energy Rev.* **2018**, *90*, 402–411.

Example outputs

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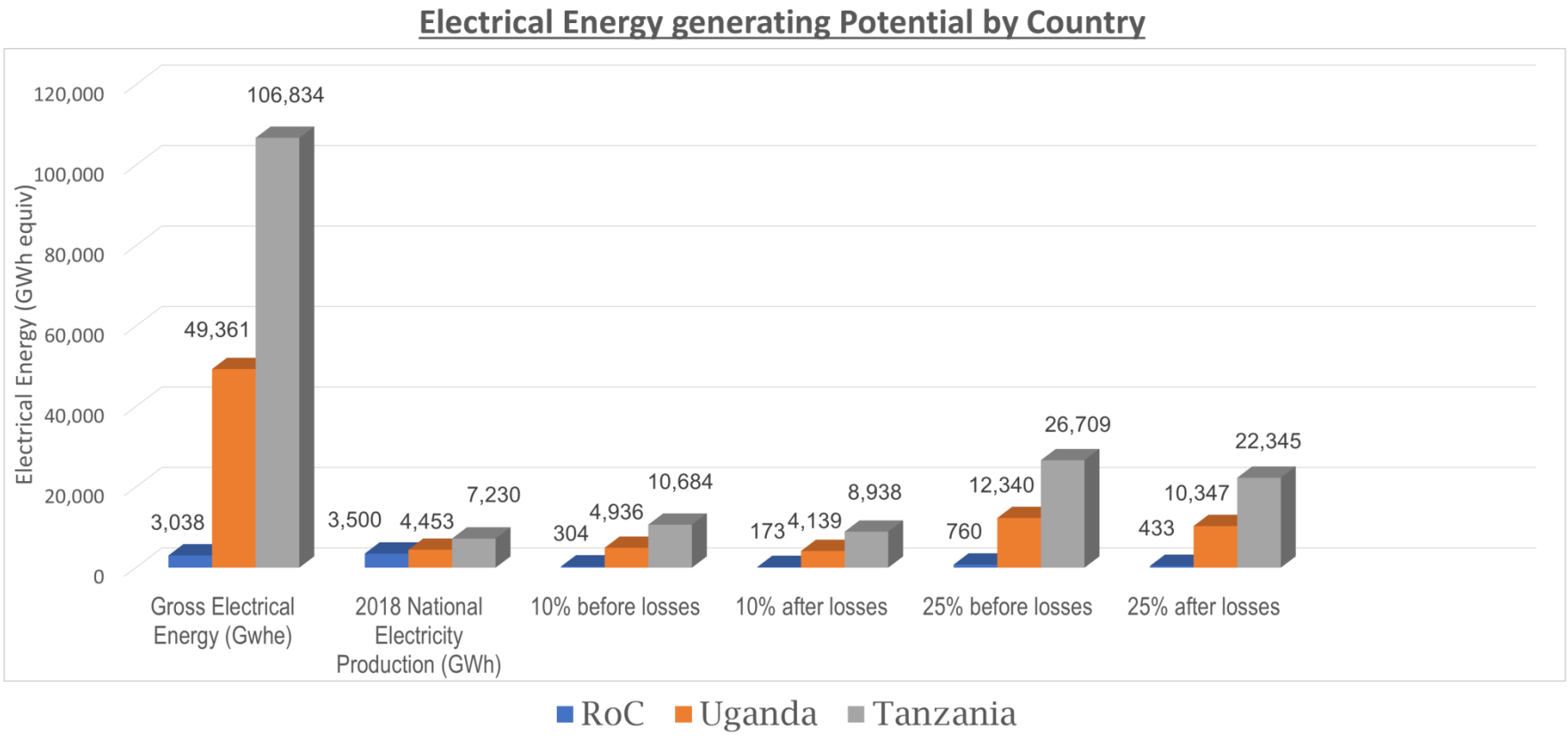

Concluding remarks

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- To utilise waste streams using the technologies discussed, it is very important to match ***supply*** with ***demand*** whilst considering the seasonal and regional availability of the feedstock.

- Knowledge of the ***local availability/supply logistics*** of waste residue streams, any competing uses, the population density, and any government incentives which can influence the uptake in this region.

- Using biomass waste residues in this manner can lead to a ***reduction in the usage and dependency on fossil fuels***, whilst making access to ***electricity more affordable***.

- Utilising these waste residues offers *environment*al *benefits* as the ***usual waste management techniques*** associated with these waste streams are avoided such a open field burning.