

Energy, Economic, and Environmental Accounting for Biomass Fuels in Ethiopia

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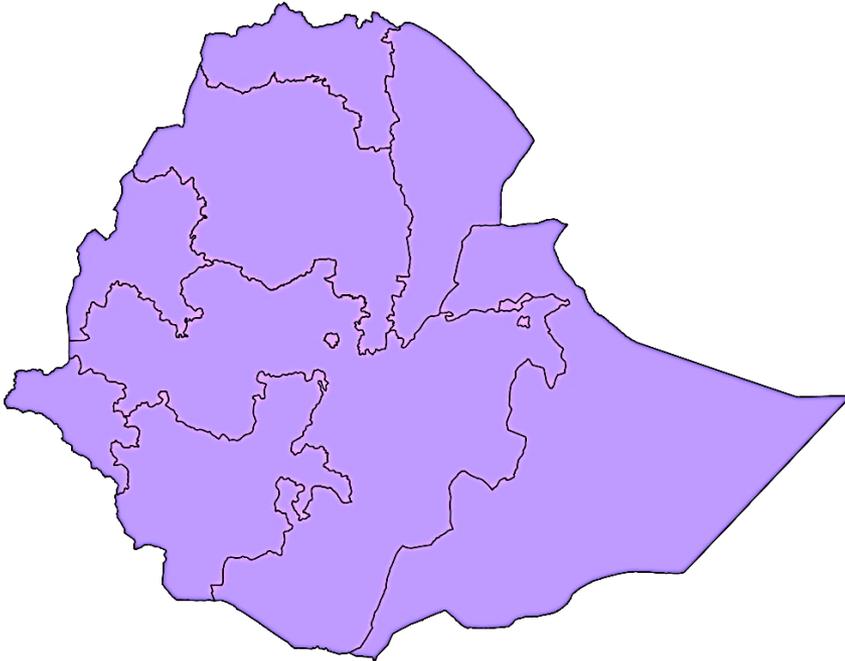
Outline

1. Introduction
2. Materials & Methods
3. Results
4. Conclusions



Introduction

Ethiopia



Overview

- Least urbanized, 23% urban (NBE, 2020)
- Low per capita GDP, US\$ 985 (NBE, 2020)
- Low per capita energy supply (IEA, 2021)
 - *Ethiopia = 0.4 toe*
 - *Italy = 2.4 toe*
 - *World = 1.9 toe*
- One of least diversified energy system in Africa (Akrof, 2021)
- Ranked 101/108 countries in **its ability to provide sustainable energy** (WEC, 2021)



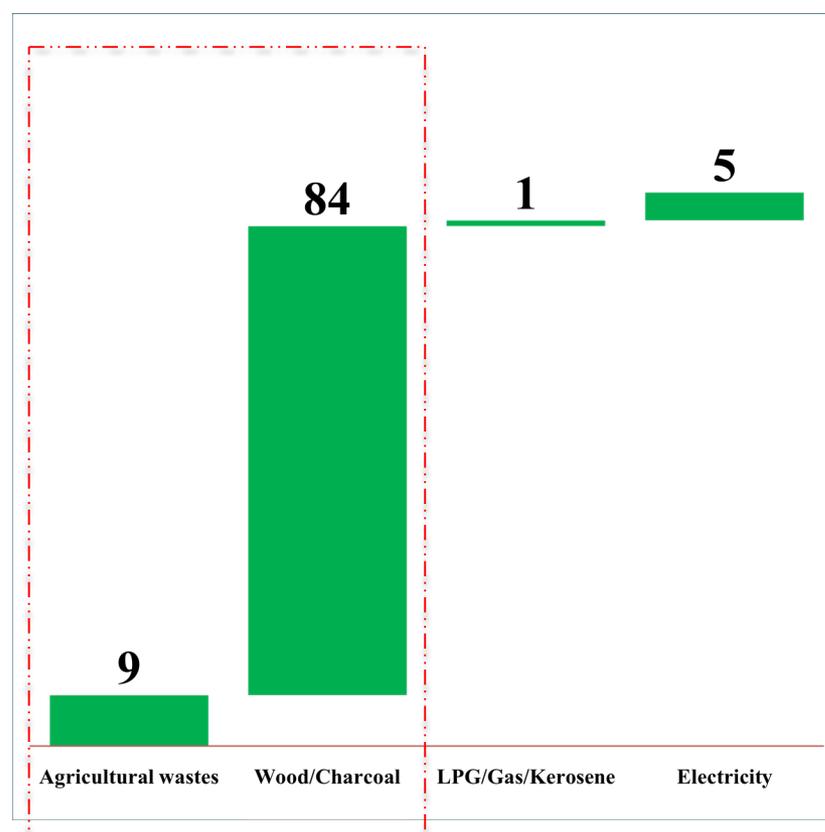
Introduction

Biomass in total energy (%)



Source: IEA (2021); Mondal et al. (2018); Senshaw (2014)

Households cooking fuel (%)



Source: CSA & ICF (2017)

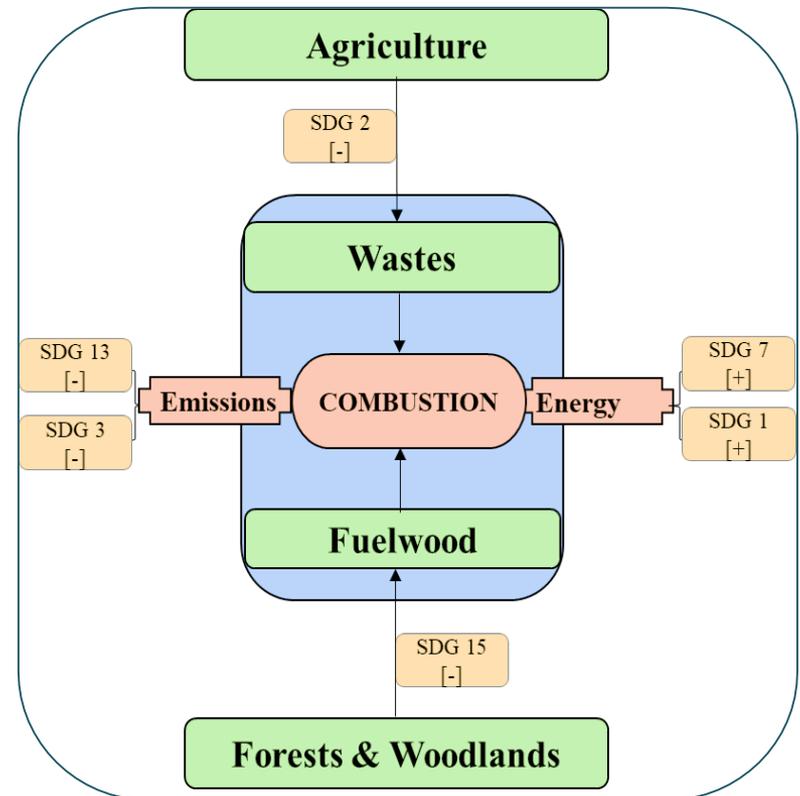


Introduction

Biomass fuels & the Environment

- Deforestation (Moges et al., 2010)
 - 1/3 of fuelwood comes from unsustainable extraction in woodlands (MoFECC 2017)
- Emissions (FDRE, 2021)
 - 46% of the total GHG emissions from the forestry sector (FDRE, 2011)
- Indoor air pollution (Adane et al., 2014)
 - 3 million DALYs and 65 thousand deaths (GHO, 2016)
- Soil nutrients (Negash et al., 2017)
 - Could lower national crop production by 2% (MoA, 2004) & agricultural GDP by 7% (Zelleke et al., 2010)

Biomass fuels & the SDGs



Introduction

Motivation

- Biomass fuels represent a clear case where energy consumption is strongly linked with the economy and the environment
- Particularity in Ethiopia, where:
 - Biomass fuels are the main source of energy (MoWIE, 2019)
 - Most households depend on biomass-fuelled traditional stoves (World Bank, 2018)
 - Smallholder agriculture is the main source of livelihood and exports (NBE, 2020)

Objective

- Estimate energy, economic contribution, GHG, and particulate matters (PM) emissions from *solid biomass fuels*
- Seeks to underpin policy responses to energy-related economic and environmental issues, and the SDGs in the country



Materials & Methods

Biomass fuels

- Solid biomass fuels
 1. Firwood
 2. Charcoal
 3. Crop residues
 4. Dungs
- Consumers
 1. Households
 2. Services
- Year
 - 2015/16 Ethiopian fiscal year

Data sources

- The mass of biomass fuel combusted
 - EUEI (2013)
 - MoWIE (2019); AFREC (2019)
 - MoFECC (2017); AgSS (2016)
- Emission factors
 - IPCC (2006) for GHG
 - Amaral et al. (2016) for PM
- Net calorific values
 - GHG Protocol (2017)
- Retail prices
 - CSA (2013, 2014, 2016)



Materials & Methods

Energy, Economic, and Environmental Accounting

$$D = \frac{M_f}{sh}$$

D = forest degradation
sh = biomass stock/ha

$$EM = \sum_{f=1}^4 e_f \cdot M_f$$

EM = emissions
e = emission factors

$$M = \sum_{f=1}^4 M_f$$

M = mass of biomass fuel
f = fuels

$$EN = \sum_{f=1}^4 c_f \cdot M_f$$

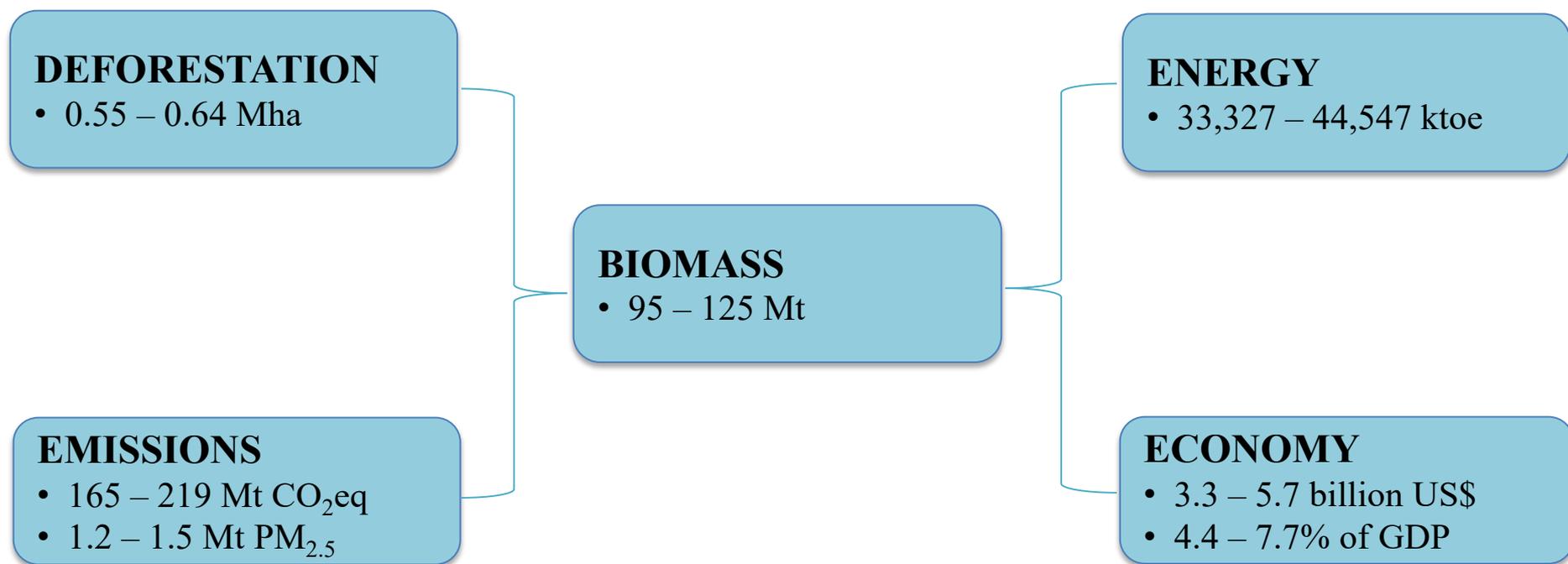
EN = energy values
c = Net calorific value

$$EC = \sum_{f=1}^4 p_f \cdot M_f$$

EC = economic values
p = retail prices



Results



Results

- Biomass fuel demand
 - Households consume about 99%
- Biomass fuel supply
 - Firewood accounts for 62 to 76%
- Energy and economic contributions
 - Comparable to previous estimates (e.g., MoFED, 2012; UNEP, 2016; MoFECC, 2017)
- GHG emissions
 - Higher than estimates in the NDC (FDRE, 2021)
 - Here we estimated the stationary combustion NOT net removals of biomass stock (IPCC, 2006)
- Effects on forest/woodlands
 - Suggests that mostly degradation corroborating previous reports (e.g., EUEI, 2013)



Conclusions

- Biomass fuels have substantial role in the Ethiopian energy system
- They however bear negative spillovers on the quality of environment and health
- Concrete actions are required to increase:
 - Households' access/use of cooking technologies
 - Households' access/use of cleaner cooking fuels/stoves
 - Afforestation/reforestation/agroforestry initiatives
- The study contributes to accounting/modeling energy systems in line with the SEEA-Energy and energy-economy-environment (E3) nexus frameworks
- Future research that applies country and fuel specific emission factors and accounting the health effects will be helpful



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THANK YOU !

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