Carbon Tools: In-Field Thermal Efficiency & Wood-to-Charcoal Conversion Factor

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Research objectives

- Create in-field protocols to measure key inputs for carbon emissions reductions methodologies
- Make recommendations for direct measurements in the future as opposed to reliance on conservative defaults

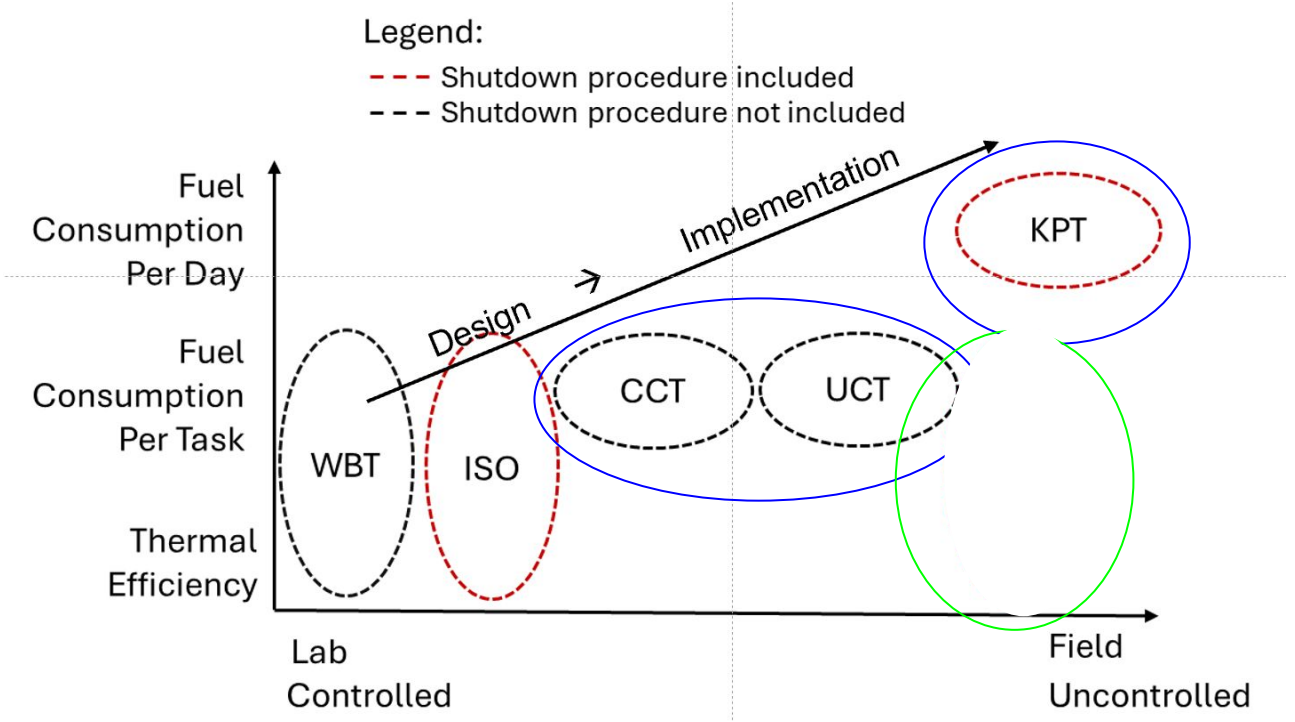
Uncontrolled Cooking Efficiency Test

Motivation for the UCET

- Create a protocol to measure thermal efficiency in field under real cooking scenarios
  - Uncontrolled Cooking Efficiency Test (UCET)
    - Cook how you want
    - Cook what you want
    - **Allows for normal shutdown procedures**
- Use the UCET to quantify the efficiency of traditional cooking to compare to UNFCCC default values

Motivation for the UCET

Uncontrolled in field thermal efficiency



UCET Methodology

- Sample Size
  - Implemented in Ghana, Malawi, and Kenya
  - Conducted 720 tests
    - 360 tests on traditional charcoal stoves
    - 360 tests on traditional wood stoves
- Household Selection
  - 30 surveys conducted in 30 households
  - 10 households selected per community
- Measures thermal efficiency using:
  - Fuel metrics
  - Change of weight and temperature of each ingredient
  - Specific heat of ingredients

Results

Wood Stoves

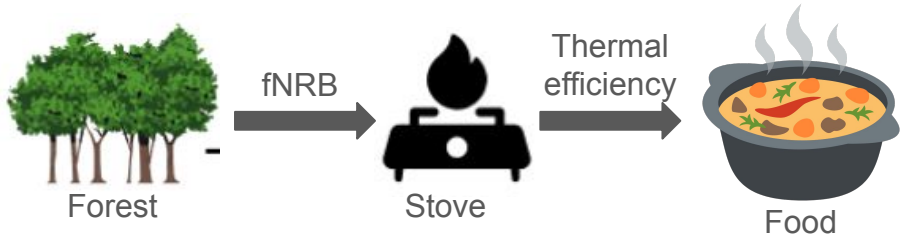
Country	Average Thermal Efficiency [%]	Median Thermal Efficiency [%]	N
Ghana	12.0 ± 5.0	11.2 ± 5.0	107
Malawi	11.1 ± 5.3	10.0 ± 5.3	108
Kenya	12.3 ± 5.5	10.9 ± 5.5	105
Average	**11.8 ± 5.3**	**10.8 ± 5.3**	**320**
Current UNFCCC Default			**15%**
Previous UNFCCC Default			**10%**

Charcoal Stoves

Country	Average Thermal Efficiency [%]	Median Thermal Efficiency [%]	N
Ghana	20.7 ± 8.6	19.3 ± 8.6	112
Malawi	26.5 ± 9.7	26.7 ± 9.7	104
Kenya	19.5 ± 9.5	17.6 ± 9.5	106
Average	**22.1± 9.8**	**21.4 ± 9.8**	**322**
Current UNFCCC Default			**25%**
Previous UNFCCC Default			**20%**

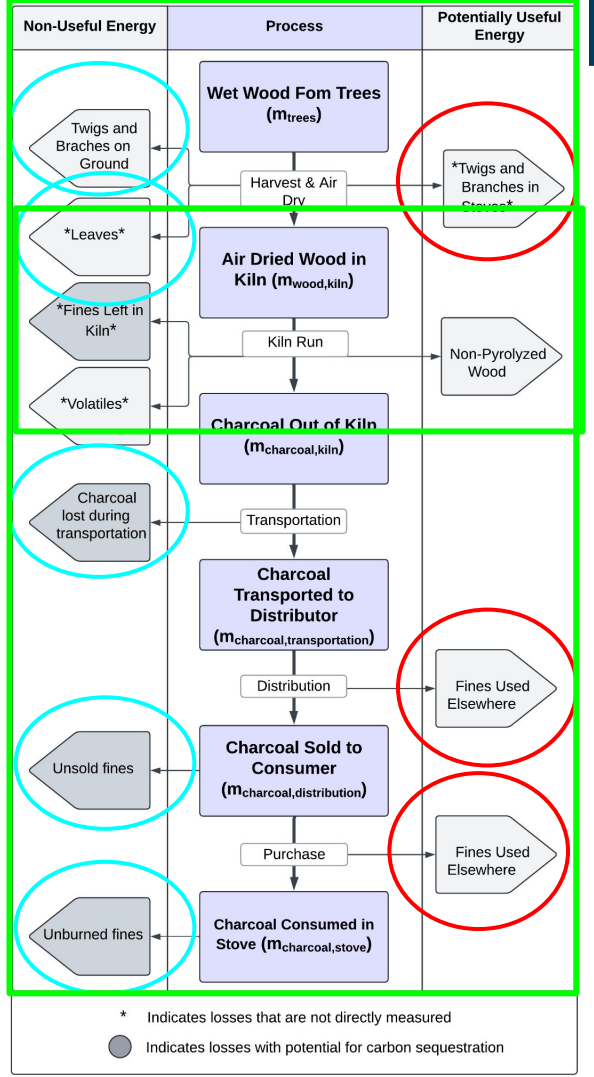
Implications & Recommendations

- In-field efficiency lies between UNFCCC defaults
- Representative of stove performance in field
  - Local cooking methods
  - Local dishes
  - Stove management methods
- Useful as a later stage metric for stove implementation
- Local efficiency values for traditional and improved stoves



Charcoal Value Chain Conversion Factor

Motivation for Charcoal Conversion Protocol



No current published protocol for charcoal conversion factor

Accounts for mass/energy losses along the charcoal value chain in addition to the kiln itself

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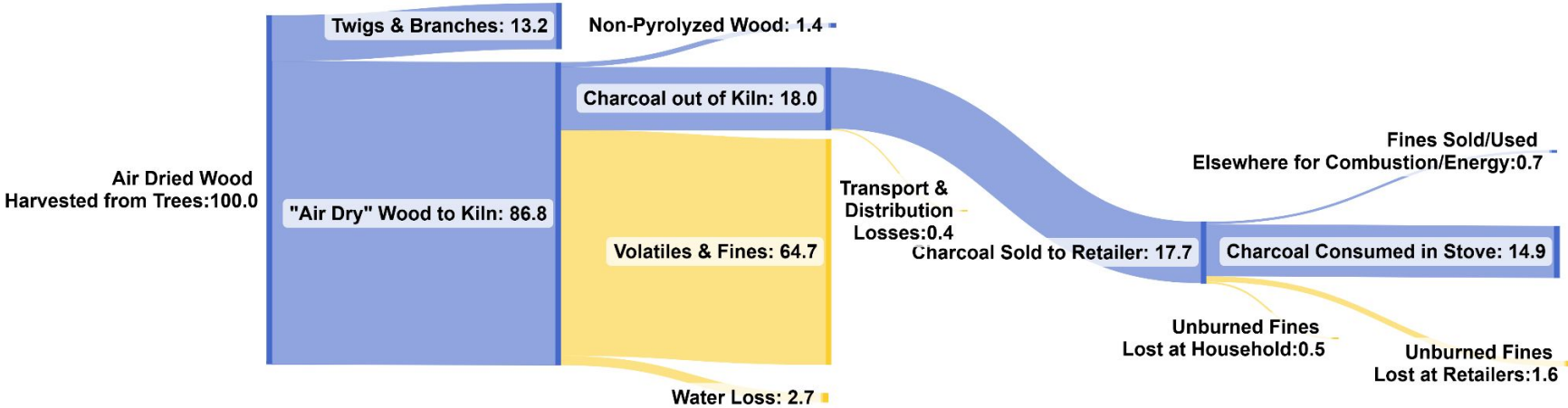
Charcoal Conversion Methodology

- Measure 12 kilns in each country
  - Malawi and Ghana
- Track mass from the wood harvest site to useable charcoal in the stove
  - Mass of wood harvested/used to mass of charcoal created
  - Mass of charcoal at the start and end of each stage

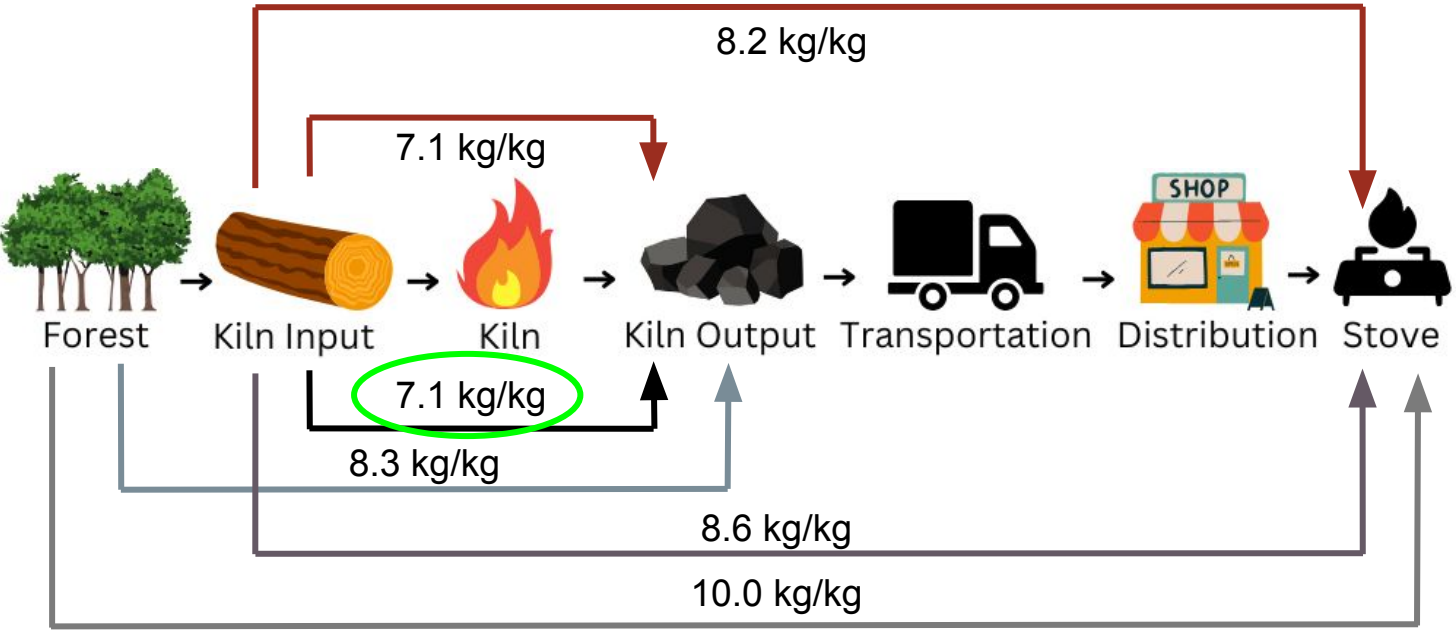
Results - Energy Yields & Losses

Normalized energy (kJ) at each stage of the charcoal supply chain in Malawi and Ghana.

- Blue represents potentially useful energy (energy yield)
- Yellow represents non-useful energy (energy loss).



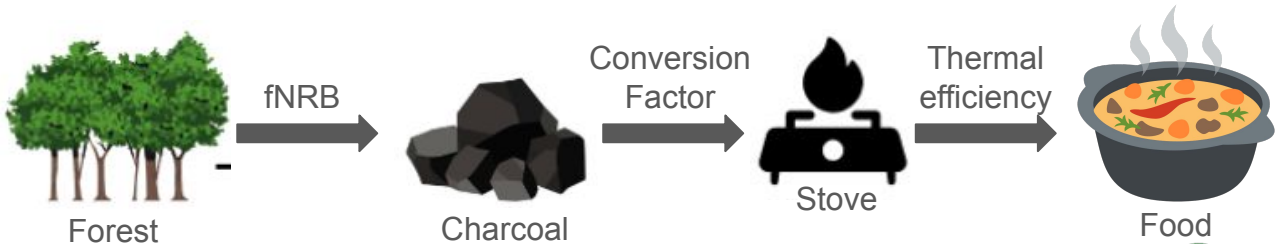
Results - Conversion Factors



UNFCCC Previous Default Wood-to-Charcoal Conversion Rate
6 kg of wood : 1 kg of charcoal
UNFCCC Current Default Wood-to-Charcoal Conversion Rate
4 kg of wood : 1 kg of charcoal

Conclusion & Implications

- Establishing a protocol to measure charcoal conversion factor
  - Complete charcoal value chain considered in conversion factors
    - 16.7% of mass losses (17.7% of energy losses) occur outside of kiln
- Accounting of useful energy
  - Can be considered as a loss or not in the conversion factors
- UNFCCC value is strongly conservative compared to results
- Better defined upstream emission impact
  - Factored into fuel change from charcoal



Acknowledgements

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- Field staff
- Project participants

For the full protocols visit:
aprovecho.org/publications

Come to our breakout session!

For more detailed information on methodology and results

Today at 2:15 PM - Breakout Session 2B

Thank You!