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Institutional Stove Carbon Offset, Fuel Savings, and Energy Savings Comparisons

How to Read this Document

The following pages compare the CO_2 emissions, fuel, and energy savings of InStove stoves to various sources of pollution and consumption found in Western countries. Section one compares the emission offsets and resource savings of an individual InStove stove to common aspects of Western life. Section two scales these comparisons to show the collective benefits of large placements of InStove stoves in service now and in the future.

All comparisons are based on values from a savings summary table found at the bottom of this page. The methodology used to create these numbers is explained in a separate document titled "Carbon, Fuel, and Energy Savings Explained (60L Stove)," available here:

http://instove.org/sites/default/files/60LStoveCarbonOffsetFuelSavings_3_25_2014_v1_2.pdf

A list of notes and references used to create these comparisons is provided at the end of this document.

Summary of Average Annual Carbon Offset, Fuel Savings, and Energy Savings per Institutional Stove Compared to Three-Stone Fire Cooking Methods

Savings Category	60L Stove	100L Stove*	
Annual Wood Fuel Savings	52,907	88,178	kg
	58.3	97.2	tons
Annual CO_2 Offset	79,360	132,266	kg
	87.5	145.8	tons
Annual Energy Savings	216.9	361.5	MWh

*Values are extrapolated proportionally from 60L stove savings based on pot capacity (60L vs. 100L). The 100L stove has been shown to be more efficient than the 60L in preliminary lab testing, meaning that these numbers are conservative estimates only. Values will be updated to reflect any additional savings of the 100L stove once final test results are available.

1. Comparison of CO2 Emissions, Fuel, and Energy Savings of One InStove Stove

A. Comparison of the Carbon Offset of One Institutional Stove

Average CO_2 Savings of One Institutional Stove

	60L Stove	100L Stove
Annual CO_2 Offset (tons)	87.5	145.8

Carbon Emission Source Statistics Used

Emission Source	Emissions (tons CO_2)	
One average American automobile [1]	0.47	*Per 1000 miles*
	5.6	*Annual total*
One average American household (Annual total) [2]	48	
One average American (Annual Total) [3]	18.6	
One-way flight from New York to London (per passenger) [4]	0.48	
Average annual sequestration of one acre of forest in the U.S. [5]	-1.34	

Equivalent Annual Carbon Offset of One Institutional Stove

CO_2 offset category	60L Stove	100L Stove
Distance driven in one American automobile (miles)	187,528	312,546
Driving trips across the United States (L.A. to New York, one way)	67	112
American automobiles (Total number)	15.6	26.0
American households	1.8	3.0
Individual Americans	4.7	7.8
Flights from New York to London (one passenger)	180	301
Forest CO_2 sequestration (acres)	65	108

Note: CO_2 is only one factor in the total climate-warming potential of a combustion emission source. Research has shown that open fires create more products of incomplete combustion (PIC) per gram of fuel burned than comparable rocket stoves, such as InStove stoves[6]. Most PIC's have a much higher warming potential than CO2, meaning that a stove's effective reduction in human-induced climate change compared to a three-stone fire can be significantly higher than is suggested by CO2 production, alone.

B. Comparison of Fuel Savings of One Institutional Stove

Average Wood Fuel Savings of One Institutional Stove

	60L Stove	100L Stove
Annual Wood Fuel Savings (tons)	58.3	97.2

Wood Resource Statistics Used*

Wood Resource	Mass of Wood (tons)
One 8 ft. long 2x4 timber	0.0048
Wood carried by an average log truck [7]	6.2
Lumber used to frame an average American house [7]	22
Firewood produced by one 12 in. diameter tree [8]	0.42
One cord of firewood (4x4x8 ft.) [8]	1.49
Approximate annual wood growth per acre of Pacific Coast Forest [9]	1.14
Total wood mass per acre of average Pacific Northwest forest [10]	50.0

*All figures are calculated to show the equivalent weight of seasoned Douglas fir with a density of 33lb/ft^3 and moisture content of 20% (percent wet basis).

Equivalent Annual Wood Savings of One Institutional Stove

Wood Savings Category	60L Stove	100L Stove
8 ft. long 2x4 timbers	12,118	20,197
Average log truck loads	9.4	15.7
Average American houses (framing only)	2.7	4.4
12 in. diameter trees (dry weight equivalent)	140.3	233.8
Cords of firewood	39.3	65.5
*Acres of forest (sustanable growth)**	51.2	85.4
Acres of forest (total wood mass)	1.2	1.9

*This value represents the number of acres of average Pacific Coast forest that would be needed to sustainably produce the amount of wood saved by one stove.

C. Comparison of Energy Savings of One Institutional Stove

Average Energy Savings of One Institutional Stove

	60L Stove	100L Stove
Annual Energy Savings (MWh)	216.9	361.5

Energy Resource Statistics Used

Energy Resource or Consumption Category	Energy (MWh)
One AA battery [11]	0.000003
One standard barrel of oil [12]	1.70
Average annual electrical consumption of one American home [13]	10.8

Equivalent Annual Energy Savings of One Institutional Stove

Energy Savings Category	60L Stove	100L Stove
AA batteries	72,305,657	120,509,429
Barrels of oil	128	213
Average American households (electrical consumption only)	20	33
*Average Americans (household electrical consumption only)**	52	86

*Assumes a household size of 2.58 people, based on data from the 2010 US census[3]

2. Comparison of CO2 Emissions, Fuel, and Energy Savings of

A. Summary of Average Annual Carbon Offset, Fuel Savings, and Energy Savings for Multiple Institutional Stoves Compared to Three-Stone Fire Cooking Methods*

Savings Category	**200 - 60L Stoves** (Current Darfur Placement)	**1,000 Stoves** (500x 60L and 500x 100L)	**10,000 Stoves** (1,000x 60L and 9,000x 100L)
Annual Wood Fuel Savings (tons)	11,664	77,759	933,111
Annual CO2 Offset (tons)	17,496	116,639	1,399,667
Annual Energy Savings (MWh)	43,383	289,223	3,470,672

*Values extrapolated from savings of an individual stove

Explanation of Stove Group Quantities: The above table shows the total savings of three groups of stoves. The first is our single largest stove placement as of 2014 (in the Darfur region). The second is the total number expected to be in service in the near future (1,000). The third is a long-term projection for future sales (10,000 stoves). Note that most stoves currently in service are 60L stoves. Demand for the recently released 100L stove is far exceeding demand for the 60L. We expect the majority of stoves sold in the future to be 100L, hence the increasing ratio of 100L to 60L stoves in future stove totals.

B. Resource and Consumption Statistics Used in Addition to Statistics from Section 1

Carbon Emission Source	**Emissions (tons CO_2)**
Average offshore oil production facility in the United States (annual emissions) [14]	67,595

Energy Resource	**Energy (MWh)**
Annual electrical consumption of Senegal [15]	2,220,000

C. Comparison of CO2 Emissions, Fuel, and Energy Savings of Multiple InStove Stoves

Equivalent Annual Carbon Offset Comparison of Multiple Institutional Stoves

CO_2 offset category	**200 - 60L Stoves** (Current Darfur Placement)	**1,000 Stoves** (500x 60L and 500x 100L)	**10,000 Stoves** (1,000x 60L and 9,000x 100L)
Distance driven in one American automobile (miles)	37,505,507	250,036,716	3,000,440,594
Driving trips across the United States (L.A. to New York)	13,395	89,299	1,071,586
Driving trips around the earth	1,506	10,041	120,495
Driving trips to the moon	157	1,047	12,559
American automobiles (Total number)	3,125	20,836	250,036
American households	364	2430	29160
Individual Americans	940	6269	75232
Flights from New York to London (one passenger)	36,084	240,557	2,886,685
Flights around the earth (one passenger)	4,982	33,213	398,555
Flights to the moon (one passenger)	519	3,462	41,542
Forest CO_2 sequestration (acres)	13,010	86,732	1,040,785
Offshore oil production facilities (total number)	0.3	1.7	20.7

Equivalent Annual Wood Savings of Multiple Institutional Stoves

Wood savings category	**200 - 60L Stoves** (Current Darfur Placement)	**1,000 Stoves** (500x 60L and 500x 100L)	**10,000 Stoves** (1,000x 60L and 9,000x 100L)
8 ft. long 2x4 timbers	2,423,665	16,157,770	193,893,238
Average log truck loads	1,885	12,567	150,806
Average American houses (framing only)	530	3,535	42,414
12 in. diameter trees (dry weight equivalent)	28,052	187,011	2,244,135
Cords of firewood	7,854	52,363	628,358
*Times the Empire State Building could be filled with firewood**	0.3	1.8	21.7
*Acres of forest (sustanable growth)***	10,245	68,300	819,597
Acres of forest (total wood mass)	233	1,554	18,649

*Based on an approximate volume of 3.7 million square feet for the Empire State building

**This value represents the number of acres of average Pacific Coast forest that would be needed to sustainably produce the amount of wood saved by the corresponding group of InStove stoves.

Equivalent Annual Energy Savings of Multiple Institutional Stoves

Energy savings category	**200 - 60L Stoves** (Current Darfur Placement)	**1,000 Stoves** (500x 60L and 500x 100L)	**10,000 Stoves** (1,000x 60L and 9,000x 100L)
AA batteries	14,461,131,455	96,407,543,033	1.16E+12
Barrels of oil	25,520	170,131	2,041,571
Average American homes (electrical consumption only)	4,003	26,688	320,261
Average Americans (household electrical consumption only)	10,328	68,856	826,274
Savings vs. electrical consumption of Senegal (savings/consumption)	0.02	0.13	1.56

Notes and References

1. Statistics derived from the US EPA Climate Question and Answer document: http://www.epa.gov/otaq/climate/documents/420f11041.pdf

2. Household carbon footprint data from the UC Berkeley Cool Climate Network: http://coolclimate.berkeley.edu/footprint

3. Derived from the 2010 US census figure of 2.58 people per household: http://www.census.gov/prod/cen2010/briefs/c2010br-14.pdf

4. Based on the 2012 UK DEFRA report figure of 79.5g CO_2 equivalent per passenger kilometer: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/69568/pb13792-

5. Taken from the US EPA Clean Energy reference page value for CO_2 sequestered per acre, per year in the average forest in the United States (accounting for live trees, soil, and undergrowth sequestration), available here:
   http://www.epa.gov/cleanenergy/energy-resources/refs.html

6. Climate change information from the Aprovecho Research Center "Laboratory Comparison of the Global-Warming Potential of Six Categories of Biomass Cooking Stoves": http://www.scscertified.com/lcs/docs/Global_warming_full_9-6-07.pdf

7. From the Idaho Forest Products Commission figure of 16,000 board feet of framing material per an average (2,400 sq. ft.) new house built in the United States and 4500 board feet per average log truck load: http://www.idahoforests.org/woodhous.htm

8. Based on values of 2970lb/cord of seasoned Douglas fir and 0.28 cords per 12" diameter tree, as outlined in a University of Idaho informational document: http://ext.wsu.edu/forestry/resources/index/documents/firewoodselection.pdf

9. Using a value of 69 cu. ft. of wood growth per acre, per year, in forests on the Pacific Coast of the United States, as given by a US Forest Service report. Assumes average composition is of species with comparable density to Douglas fir.
   http://www.fs.fed.us/rm/pubs_other/wo_gtr078_064_066.pdf

10. Based on the total volume of wood available in the Pacific Northwest of the United States (159,048 million cu. ft.) divided by the 52,449 thousand acres of timberland in that region, as given by the 2007 US Forest Service recource report. Assumes Douglas fir to be roughly representative of the average Northwestern forest species.
    http://www.fs.fed.us/nrs/pubs/gtr/gtr_wo78.pdf

11. Assumes a usable energy content of 3 Wh, based on the datasheet for an Energizer alkaline battery: http://data.energizer.com/PDFs/E91.pdf

12. From the EPA clean energy resource page value of 5.8 million btu per barrel of crude oil: http://www.epa.gov/cleanenergy/energy-resources/refs.html

13. Household electrical consumption from the US Energy Information Administration FAQ page: http://www.eia.gov/tools/faqs/faq.cfm?id=97&t=3

14. Derived from data from the 2012 US EPA Greenhouse Gas Reporting Program: http://www.epa.gov/ghgreporting/ghgdata/reported/petroleum.html

15. Taken from the CIA world factbook (2010 estimate): https://www.cia.gov/library/publications/the-world-factbook/rankorder/2233rank.html