Data Report

Economic Evaluation of the Replacement of Old Technology Wood Stoves and Fireplaces and of the Use of Alternative Fuels

prepared for:

Hearth Products Association
1601 North Kent Street, Suite 1001
Arlington, VA 22209

prepared by:

James E. Houck and Richard C. Sparwasser
OMNI Environmental Services, Inc.
5465 SW Western Avenue
Beaverton, Oregon 97005

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Introduction

OMNI Environmental Services, Inc. was contracted by the Hearth Products Association (HPA) to conduct an economic evaluation of the replacement of old technology wood stoves and fireplaces and for the use of alternative fuels. This evaluation was done primarily to support the publication of the HPA Journal article, "It's Win-Win, New Hearth Product Sales Can Be Part of the Solution for New Air Quality Regulations" and to provide information for use in preparing materials for WESTAR workshops or for other future regulatory input. It should be emphasized that this is simply a data report not meant to be released outside of the HPA.

Methods and Scope

Residential wood burning was divided into three categories: 1) Wood stoves, 2) Fireplaces used for a heat source, and 3) Fireplaces used for aesthetic and minor heating purposes. The economic evaluation was based on an estimate of national average wood usage for each of the three categories. These were 2.5 cords/year for wood stoves, 1.5 cords/year for fireplaces used as heat sources, and 0.5 cords/year for fireplaces used for aesthetic and minor heating purposes. These estimates were derived from U.S. Department of Energy survey data and best professional judgement based on various technical reports and climate data. Estimates of average purchase prices for appliances and fuels and typical costs associated with installation of new appliances were used for the evaluation.

The results of the economic evaluation were meant to provide a "sense" of cost for the various options. It should be noted that the economic feasibility methodology section of EPA's guidance document for residential wood combustion best available control measures (EPA-450/2-92-002) does not provide any numbers. Clearly, the costs will vary regionally based on wood usage and local fuel and utility costs. It is assumed that the economic evaluation developed for the HPA and reported here can be used as a starting point with regional refinements made as needed.

Organization of the Data

For each of the three categories of residential wood combustion two tables and one appendix have been prepared. One table lists the initial costs for the alternative, one table lists the annualized operation cost differences of each alternative as compared to a conventional stove or traditional fireplace burning cordwood, and the appendix provides the data, assumptions and calculations to support the results listed in the tables.

1. Wood Stoves

Table 1 — Initial Costs for Alternatives to Conventional Stoves Burning Cordwood

Table 2 — Annualized Operation Cost Differences for Alternatives to Conventional Stoves Burning Cordwood

Appendix A — Data, Assumptions and Calculations for Alternatives to Conventional Stoves Burning Cordwood

2. Fireplaces Used for Heating

Table 3 — Initial Costs for Alternatives to Fireplaces Used for Heating

Table 4 — Annualized Operation Cost Differences for Alternatives to Fireplaces Used for Heating

Appendix B — Data, Assumptions and Calculations for Alternatives to Fireplaces Used for Heating

3. Fireplaces Used for Aesthetic and Minor Heating Purposes

Table 5 — Initial Costs for Alternatives to Fireplaces Burning Cordwood for Aesthetic and Minor Heating Purposes

Table 6 — Annualized Operation Cost Differences for Alternatives to Fireplaces Burning Cordwood for Aesthetic and Minor Heating Purposes

Appendix C— Data, Assumptions and Calculations for Alternatives to Fireplaces Burning Cordwood for Aesthetic and Minor Heating Purposes

Table 1
Initial Costs for Alternatives to Conventional Stoves Burning Cordwood

Alternative	Unit purchase price	Installation costs	Cost of chimney work	Total initial costs
Certified non-cat.	$1250	$125	$700	$2075
Certified cat.	$1600	$125	$700	$2425
Pellet	$1900	$125	$360	$2385
Masonry heater	$9000	$1000	$500	$10,500
Densified fuel	-	-	-	$0

Table 2
Annualized Operation Cost Differences for Alternatives to Conventional Stoves Burning Cordwood

Alternative	Annual difference in fuel costs	Annualized difference in chimney cleaning costs	Other annualized costs (electricity & cat. replacement)	Total annualized cost difference from burning cordwood in conv. stoves
Certified non-cat.	-$67	$0	-	-$67
Certified cat.	-$81	$25	$40	-$16
Pellet	$29	$0	$116	$145
Masonry heater	-$24	$-85	-	-$109
Densified fuel	$291	$0	-	$291

Table 3
Initial Costs for Alternatives to Fireplaces Used for Heating

Alternative	Unit purchase price	Installation costs	Cost of chimney work	Total initial costs
Certified non-cat. insert	$1250	$200	$400	$1850
Certified cat. insert	$1600	$200	$400	$2200
Pellet insert	$1900	$200	$300	$2400
Gas insert	$1500	$500	$300	$2300

Table 4
Annualized Operation Cost Differences for Alternatives to Fireplaces Used for Heating

Alternative	Annual difference in fuel costs	Annualized difference in chimney cleaning costs	Other annualized costs (electricity & cat. replacement)	Total annualized cost difference from cordwood in fireplace
Certified non-cat. insert	-$146	$110	$25	-$11
Certified cat. insert	-$148	$135	$65	$52
Pellet Insert	-$129	$110	$72	$53
Gas insert, nat. gas	-$151	-$15	$27	-$139
Gas insert, LPG	-$114	-$15	$27	-$102

Table 5
Initial Costs for Alternatives to Fireplaces Burning Cordwood for Aesthetic and Minor Heating Purposes

Alternative	Unit purchase price	Installation costs	Total initial costs
Wax firelogs	-	-	$0
Gas logs	$200	$450	$650

Table 6
Annualized Operation Cost Differences for Alternatives to Fireplaces Burning Cordwood for Aesthetic and Minor Heating Purposes

Alternative	Annual difference in fuel costs	Annualized difference in chimney cleaning costs	Total annualized cost difference from burning cordwood in fireplaces
Wax firelogs	$166	$0	$166
Gas logs, nat. gas	$0	-$15	-$15
Gas logs, LPG	$62	-$15	$47

Appendix A
Data, Assumptions and Calculations for Alternatives to Conventional Stoves Burning Cordwood

- Unit purchase price based on mid-range appliances.
- Installation cost assumes old hearth and wall protection suitable for new unit.
- For non-cat. and cat. stoves, replacement of old 1700°F chimney with new 103HT 2100°F chimney necessary.
- Masonry heater installation cost includes foundation preparation.
- The value of a masonry heater adds to the basis of value for a home and is generally recovered on the sale of the home.
- Densified fuel is more widely available in the Western U.S.
- Annual chimney cleaning for cat. stove requires additional work (cost) due to catalyst and bypass. Annual chimney cleaning cost for conventional and non-cat. stove is $125, annual chimney cleaning cost for cat. stove is $150.
- Pellet stove annual flue cleaning and servicing of electronic and moving parts costs $125.
- Masonry heater chimney cleaning once every five years, includes gasket inspection/replacement and ash clean-out, costs $200. Difference in annualized chimney cleaning costs between conventional wood stove and masonry heater is:

  $200/5yrs - $125/yr = -$85/yr.

- Catalyst replacement once every three years at $120.
- Pellet stove requires 380 watts electricity for fan and electronic components. Typical electric cost is $0.12 per kilowatt-hour. Length of heating season is six months (Oct.-March), pellet stove operates on the average of 14 hours per day during heating season.

  (380 watts) X (14 hrs/day) X (182 days /heating season) X ($0.12/kw-hr) (kw /1000 watts) = $116.

- Efficiencies: conventional stove 54%, certified non-cat. 68%, certified cat. 72%, pellet 78%, masonry heater 58%, conventional stove with densified fuel 57%.
- Pellets, densified logs and cordwood all have approximately the same heat content per dry weight, i.e., 8800 Btu/lb.

- National average cordwood usage per year in a conventional stove — 2.5 cords.
- Weight of dry cord is 1.163 tons.
- National average Btu output for conventional stove =

  (.54) X (2.5 cords/yr) X (1.163 tons/cord) X (2000 lbs/ton) X (8800 Btu/lb) = 27.6 MBtu/yr.

- Average cost (value) of cordwood $125/cord.
- Average cost of cordwood burned in a conventional stove

  (2.5 cords/yr) X ($125/cord) = $315/yr.

- Average cost of pellets is $160/ton.
- Average moisture content of pellets is 7%, dry basis.
- Average cost of densified logs is $200/ton.
- Average moisture content of densified logs is 10%, dry basis.
- Difference in annual fuel costs.

  Non-cat. $(2.76 \times 10^7$ Btu) / ([.68] X [8800 Btu/lb]) = 4612 dry lbs
  (4612 dry lbs) / ([2000 lbs/ton] X [1.163 tons/dry cord]) = 1.98 cords
  (1.98 cords) X ($125/cord) = $248
  $248- $315 = -$67

  Cat. $(2.76 \times 10^7$ Btu) / ([.72] X [8800 Btu/lb]) = 4356 dry lbs
  (4356 dry lbs) / ([2000 lbs/ton] X [1.163 tons/dry cord]) = 1.87 cords
  (1.87 cords) X ($125/cord) = $234
  $234-$315 = -$81

  Masonry heater $(2.76 \times 10^7$ Btu) / ([.58] X [8800 Btu/lb]) = 5407 dry lbs
  (5407 dry lbs) / ([2000 lbs/ton] X [1.163 tons/dry cord]) = 2.32 cords
  (2.32 cords) X ($125/cord) = $291
  $291- 315 = -$24

Pellet $(2.76 \times 10^7 \text{ Btu}) / ([.78] \text{ X } [8800 \text{ Btu/lb}]) = 4021$ dry lbs pellets
(4021 dry lbs) X (1.07 wet/dry) / (2000 lbs/ton) = 2.15 wet tons
(2.15 tons) X $160/ton = $344
$344- $315 = $29

Conv. densified fuel $(2.76 \times 10^7 \text{ Btu}) / ([.57]] \text{ X } [8800 \text{ Btu/lb}]) = 5502$ dry lbs
(5502 dry lbs) X (1.10 wet/dry) / (2000 lbs/ton) = 3.03 wet tons
(3.03 tons) X $200/ton = $606
$606 - $315 = $291.

Appendix B
Data, Assumptions and Calculations for Alternatives to Fireplaces Used for Heating

- Unit purchase price based on mid-range appliance.
- Chimney cleaning for fireplaces once every 5 years at $75.
- Chimney cleaning for non-cat. and cat. inserts once per year at $125 for non-cat. and $150 for cat.
- Flue cleaning for pellet stoves once per year and includes servicing of electronic and moving parts — $125/year.
- Annualized differences in chimney cleaning costs for various options versus fireplace are:

  Non-cat. insert $125/yr - $75/5 yrs = $110
  Cat. insert $150/yr - $75/5 yrs = $135
  Pellet insert $125/yr - $75/5 yrs = $110
  Gas insert $0 - $75/5 yrs = -$15

- Gas appliance installation includes hook-up at $125 and running gas line from another part of the home at $375.
- Catalyst replacement once every three years at $120.
- Natural gas costs $0.60/ 100,000 Btu, LPG costs $1.10/gallon, 91,500 Btu/gallon.
- Typical electric cost is $0.12/kw-hr.
- National average cordwood usage per year in a fireplace used for heating is 1.5 cords.
- Weight of dry cord is 1.1163 tons.
- Average cost (value) of cordwood is $125/cord.
- Average cost of cordwood burned in fireplace for heat

  (1.5 cords) X ($125/cord) = $188

- Average cost of pellets is $160/ton
- Typical moisture of pellets is 7%, dry basis.
- Efficiencies: fireplace used for heat source 15%, non-cat. insert 66%, cat. insert 70%,

pellet insert 76%, and gas insert 75%.

- Electric fan on non-cat., cat, and gas inserts — (1.25 amp) X (110 volts) = 144 watts.
- Electric fan, moving and electronic components on pellet insert — 380 watts.
- Six month (Oct-March) heating season — 182 days.
- Pellet and gas insert power usage and costs

  60 days @ 14 hrs/day = 840 hrs
  60 days @ 8 hrs/day = 280 hrs
  62 days @ 4 hrs/day = 248 hrs
  Total = 1568 hrs.

  Pellet electricity costs (1568 hrs) X (0.380 kw) X ($0.12/ kw-hr) = $72

  Gas insert electricity costs (1568 hrs) X (0.144 kw) X ($0.12/ kw-hr) = $27.

- Non-cat. and cat. insert power usage and costs

  60 days @ 14 hrs = 840 hrs
  122 days @ 5 hrs = 610 hrs
  Total = 1450 hrs

  Non-cat. and cat. electricity costs (1450 hrs) X (0.144 kw) X ($0.12/ kw-hr) = $25.

- National average Btu output for fireplace used as a heating source

  (.15) X (1.5 cords/yr) X (1.163 tons/cord) X (2000 lbs/ton) X (8800 Btu/lb) = 4.60 MBtu.

- Difference in annual fuel costs

  Non-cat. insert(4.60 x 10^6 Btu)/ ([.66] X [8800Btu/lb]) = 792 dry lbs
  (792 dry lbs) /([2000 lbs/ton] X [1.163 tons/dry cord]) = 0.34 cords
  (0.34 cords) X ($125/cord) = $42
  $42- $188 = -$146

Cat. insert	(4.60×10^6 Btu) / ([.70] X [8800 Btu/lb]) = 747 dry lbs (747 dry lbs)/([2000 lbs/ton] X [1.163 tons/dry cord]) = 0.32 cords (0.32 cords) X ($ 125/cord) = $40 $40- $188 = -$148
Pellet insert	(4.60×10^6 Btu) / ([.76]) X [8800 Btu/lb]) = 688 dry lbs pellets. (688 dry lbs) X (1.07 wet/dry)/ 2000 lbs/ton = 0.37 wet tons (0.37 tons) X ($160/ton) = $59 $59-$188 = -$129
Gas insert, nat. gas	(4.60×10^6 Btu) X ($0.60/100,000 Btu) / (.75) = $37 $37- $188 = $151
Gas insert, LPG	(4.60×10^6 Btu) X ($1.10/gal) / (91,500 Btu/gal) X (.75) = $74 $74-$188 = $114

Appendix C
Data, Assumptions and Calculations for Alternatives to Fireplaces Burning Cordwood for Aesthetic and Minor Heating Purposes

- Typical fireplace burning cordwood for aesthetic and minor heating purposes uses 0.5 cords per year.

- Cordwood cost per year

  (0.5 cords) X ($125/ cord) = $62

- Heating season (Oct-March) six months (26 weeks), typical fireplace used 4 hrs at a time, two times a week.

- Burn rate check , assume typical cordwood 20% moisture (dry basis) and weight of dry cord 1.163 tons.

  (0.5 cord) X (1.163 tons/dry cord) X (2000 lbs/ ton) X (1.2 wet/dry) = 1396 lbs

  (26 weeks) X (2 burns/week) X (4 hours/burn) = 208 hrs

  1396 lbs/ 208 hrs = 6.7 lbs/hr

  J. Shelton fireplace research found 3 kg/hr (6.6 lbs/hr) typical burn rate for fireplace.

- Annual chimney cleaning cost and frequency the same for fireplaces burning cordwood and wax firelogs — $75 once every five years

- Gas log installation includes hook-up ($75) and running gas line from another part of the home ($375).

- Typically two 5 or 6 lb wax firelogs burned per burn, cost per log $2.20.

- Decorative gas log heat input 50,000 Btu/hr, natural gas $0.60/100,000 Btu, LPG $1.10/gallon, 91,500 Btu/gallon.

- Difference in fuel costs

  Wax firelogs (2 logs/burn) X (2 burns/week) X 26 weeks/heating season = 104 firelogs
  (104 firelogs) X ($2.20/firelog) = $229
  $229-$ 62 = $167

Decorative gas logs	nat. gas (50,000 Btu/hr) X ($0.60/100,000) X (208 hrs) = $62 $62- $62 = $0 LPG (50,000 Btu/hr) X ($1.10/gallon) X (208 hrs) /(91,500 Btu/gallon) = $125 $125-$62 = $63

- Btu comparisons

Cordwood	(0.5 cords/yr) X (1.163 tons/dry cord) X (2000 lbs/ton) X (8800Btu/lb) = 10.2 MBtu $(1.02 \times 10^7$ Btu) / 208 hrs = 4.90×10^4 Btu/hr
Wax firelog	(2 logs/burn) X (2 burns/week) X (26 weeks) X (15,000 Btu/lb) X (6 lbs/log) X (1/1.03 dry/wet) = 9.08×10^6 Btu $(9.08 \times 10^6$ Btu)/ 208 hrs = 4.37×10^4 Btu/hr
Decorative gas log	5.00×10^4 Btu/hr