

APPENDIX E. ENGINEERING ANALYSIS COST AND EFFICIENCY TABLES

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APPENDIX E. ENGINEERING ANALYSIS COST AND EFFICIENCY TABLES

E.1 NOTE

This appendix contains the cost and efficiency tables described in Chapter 6, section 6.7.4 of the Furnace and Boiler Technical Support Document (TSD). Non-weatherized gas furnaces was the only product class that DOE analyzed using three installation cost scenarios: Installation Model (by DOE), Natural Resources Canada (NRCan), and the Gas Research Institute (GRI). The Department based the payback periods on the calculation methodology found in the DOE furnace/boiler test procedure; these payback periods may differ from those found under field conditions.

Table E.1.1 Cost Table for Non-Weatherized Gas Furnaces

ID	Efficiency Levels & Design Options	Cost Data								
		Manufacturer Costs (per unit)						Consumer Costs		
		Material	Labor	Transportation	Overhead	Total	Incremental	Retail	Installation	Maintenance
		\$	\$	\$	\$	\$	\$	\$	\$	\$
0	78% AFUE-Baseline Non-Weatherised	240.13	57.76	19.62	31.44	348.95		1,089.19	760.00	39.05
1.1	80% AFUE(A)-Increased HXArea	242.39	58.55	19.62	31.91	352.46	3.51	1,096.45	764.00	39.05
1.2	80% AFUE(B)-Improved Heat Transfer Coef	242.99	61.82	19.62	32.80	357.22	8.27	1,106.32	764.00	39.05
1.3	80% AFUE(C)-Modulation(2-stage)	376.92	58.55	19.62	31.91	487.00	138.04	1,375.03	764.00	48.81
2.1	81% AFUE(A)-Increased HXArea	255.99	58.55	19.62	32.22	366.37	17.42	1,125.26	801.00	39.05
2.2	81% AFUE(B)-Improved Heat Transfer Coef	254.56	61.84	19.62	32.94	368.97	20.01	1,130.64	801.00	39.05
2.3	81% AFUE(C)-Modulation (2-stage)	390.53	58.55	19.62	32.22	500.91	151.96	1,403.83	801.00	48.81
5.1	90% AFUE-Baseline Condensing	373.88	62.94	23.88	48.78	509.48	160.53	1,421.58	999.00	39.05
6.1	92% AFUE(A)-Increased HXArea	440.53	77.49	26.27	48.78	593.07	244.11	1,594.65	999.00	39.05
6.2	92% AFUE(C)-Modulation (2-stage)	575.07	58.55	26.27	48.78	708.66	359.71	1,834.00	999.00	48.81
6.3	92% AFUE(D)-Modulation (Continuous)	575.07	77.49	26.27	48.78	727.61	378.65	1,873.23	999.00	48.81
7.1	96% AFUE(D)-Modulation (Continuous)	782.16	86.40	35.37	63.10	967.03	618.08	2,368.98	999.00	48.81

Table E.1.2 Energy and Economics Table for Non-Weatherized Gas Furnaces

ID	Efficiency Levels & Design Options	Energy Use Data			Summary Economics		
					Total Costs		
		BOH	Fuel	Electric	Total Installed	Total Operating	Simple Payback
		hr	Mbtu/yr	kWh/yr	\$	\$/yr	years
0	78% AFUE-Baseline Non-Weatherised	792	59.42	558	1,849	586	
1.1	80% AFUE(A)-Increased HXArea	773	57.99	545	1,860	573	0.9
1.2	80% AFUE(B)-Improved Heat Transfer Coef	773	57.99	545	1,870	573	1.6
1.3	80% AFUE(C)-Modulation(2-stage)	757	56.77	484	2,139	567	15.5
2.1	81% AFUE(A)-Increased HXArea	1,019	76.39	718	1,926	742	-0.5
2.2	81% AFUE(B)-Improved Heat Transfer Coef	1,019	76.39	718	1,932	742	-0.5
2.3	81% AFUE(C)-Modulation (2-stage)	997	74.81	638	2,205	732	-2.4
5.1	90% AFUE-Baseline Condensing	920	68.99	648	2,421	674	-6.5
6.1	92% AFUE(A)-Increased HXArea	900	67.53	635	2,594	661	-10.0
6.2	92% AFUE(C)-Modulation (2-stage)	866	64.94	554	2,833	642	-17.6
6.3	92% AFUE(D)-Modulation (Continuous)	884	66.30	566	2,872	654	-15.0
7.1	96% AFUE(D)-Modulation (Continuous)	849	63.66	542	3,368	630	34.3

Table E.1.3 Cost Table for Weatherized Gas Furnaces

ID	Efficiency Levels & Design Options	Cost Data								
		Manufacturer Costs (per unit)						Consumer Costs		
		Material	Labor	Transportation	Overhead	Total	Incremental	Retail	Installation	Maintenance
		\$	\$	\$	\$	\$	\$	\$	\$	\$
0	78% AFUE-Baseline	542.78	80.57	23.94	110.96	758.25		2,366.73	1,197.82	39.05
1.1	80% AFUE-Increased HXArea	545.03	81.35	23.94	111.42	761.74	3.50	2,373.97	1,197.82	39.05
1.2	80% AFUE-Improved Heat Transfer Coef	545.55	84.63	23.94	112.30	766.42	8.18	2,383.66	1,197.82	39.05
2.1	81% AFUE-Increased HXArea	548.43	81.36	23.94	111.69	765.42	7.18	2,381.59	1,197.82	39.05
2.2	81% AFUE-Improved Heat Transfer Coef	546.69	84.65	23.94	112.41	767.69	9.45	2,386.29	1,197.82	39.05
3.1	82% AFUE-Increased HXArea	551.21	81.36	23.94	112.05	768.55	10.31	2,388.08	1,197.82	39.05
3.2	82% AFUE-Improved Heat Transfer Coef	548.20	84.65	23.94	112.58	769.36	11.12	2,389.75	1,197.82	39.05
4.1	83% AFUE-Increased HXArea	556.38	81.36	23.94	112.45	774.12	15.87	2,399.60	1,197.82	65.08
4.2	83% AFUE-Improved Heat Transfer Coef	552.05	83.26	23.94	112.57	771.82	13.58	2,394.84	1,197.82	65.08

Table E.1.4 Energy and Economics Table for Weatherized Gas Furnaces

ID	Efficiency Levels & Design Options	Energy Use Data			Summary Economics		
					Total Costs		
		BOH	Fuel	Electric	Total Installed	Total Operating	Simple Payback
		hr	Mbtu/yr	kWh/yr	\$	\$/yr	years
0	78% AFUE-Baseline	792	59.42	558	3,565	586	
1.1	80% AFUE-Increased HXArea	773	57.99	545	3,572	573	0.5
1.2	80% AFUE-Improved Heat Transfer Coef	772	57.88	544	3,581	572	1.2
2.1	81% AFUE-Increased HXArea	764	57.29	538	3,579	567	0.8
2.2	81% AFUE-Improved Heat Transfer Coef	763	57.19	537	3,584	566	1.0
3.1	82% AFUE-Increased HXArea	755	56.62	532	3,586	560	0.8
3.2	82% AFUE-Improved Heat Transfer Coef	754	56.52	531	3,588	559	0.9
4.1	83% AFUE-Increased HXArea	751	56.29	529	3,597	583	11.7
4.2	83% AFUE-Improved Heat Transfer Coef	745	55.86	525	3,593	579	4.2

Table E.1.5 Cost Table for Mobile Home Gas Furnaces

ID	Efficiency Levels & Design Options	Cost Data								
		Manufacturer Costs (per unit)						Consumer Costs		
		Material	Labor	Transportation	Overhead	Total	Incremental	Retail	Installation	Maintenance
		\$	\$	\$	\$	\$	\$	\$	\$	\$
0	75% AFUE-Baseline	184.31	39.35	39.94	20.99	284.59		796.04	0.00	4.25
1.1	80% AFUE-Increased HXArea	207.49	43.55	39.94	22.51	313.48	28.89	876.86	0.00	18.95
1.2	80% AFUE Modulation 2 stage	342.03	43.55	39.94	22.51	448.02	163.43	1,253.19	0.00	23.26
2.1	81% AFUE-Increased HXArea	212.49	44.85	41.13	22.51	320.98	36.40	897.85	72.00	18.95
2.2	81% AFUE Modulation 2 stage	347.03	44.85	41.13	22.51	455.52	170.94	1,274.18	72.00	23.26
3.1	82% AFUE-Increased HXArea	220.49	45.75	42.37	22.51	331.11	46.53	926.19	72.00	18.95
3.2	82% AFUE Modulation 2 stage	355.03	45.75	42.37	22.51	465.65	181.07	1,302.52	72.00	23.26
4.1	90% AFUE Condensing	294.03	54.90	47.92	27.01	423.86	139.27	1,185.62	53.00	25.55

Table E.1.6 Energy and Economics Table for Mobile Home Gas Furnaces

ID	Efficiency Levels & Design Options	Energy Use Data			Summary Economics		
					Total Costs		
		BOH	Fuel	Electric	Total Installed	Total Operating	Simple Payback
		hr	Mbtu/yr	kWh/yr	\$	\$/yr	years
0	75% AFUE-Baseline	781	62.57	500	796	737	
1.1	80% AFUE-Increased HXArea	773	57.99	545	877	705	2.5
1.2	80% AFUE Modulation 2 stage	757	56.77	484	1,253	691	9.9
2.1	81% AFUE-Increased HXArea	1019	76.39	718	970	922	-0.9
2.2	81% AFUE Modulation 2 stage	997	74.81	638	1,346	903	-3.3
3.1	82% AFUE-Increased HXArea	1007	75.49	709	998	912	-1.2
3.2	82% AFUE Modulation 2 stage	986	73.95	631	1,375	892	-3.7
4.1	90% AFUE Condensing	920	68.99	648	1,239	841	-4.2

Table E.1.7 Cost Table for Oil-Fired Furnaces

ID	Efficiency Levels & Design Options	Cost Data								
		Manufacturer Costs (per unit)						Consumer Costs		
		Material	Labor	Transportation	Overhead	Total	Incremental	Retail	Installation	Maintenance
		\$	\$	\$	\$	\$	\$	\$	\$	\$
0	78% AFUE-Baseline	378.87	131.87	37.03	71.03	618.80		1,838.05	539.00	110.44
1	80% AFUE-Increased HXArea	380.87	131.87	37.03	71.03	620.80	2.00	1,842.03	539.00	110.44
2.1	81% AFUE-Increased HXArea	383.45	132.25	37.03	71.30	624.02	5.22	1,848.45	539.00	110.44
2.1.1	81% AFUE Interrupted Ignition	395.37	131.87	37.03	71.03	635.30	16.50	1,870.89	539.00	110.44
2.2	81% AFUE Fan Atomized Burner w/Two-stage Modulation	516.45	138.25	37.77	76.30	768.76	149.96	2,136.54	539.00	110.44
3.1	82% AFUE-Increased HXArea	385.13	132.25	37.03	71.30	625.71	6.91	1,851.80	539.00	110.44
3.1.1	82% AFUE Interrupted Ignition	401.63	132.25	37.03	71.30	642.21	23.41	1,884.64	539.00	110.44
3.2	82% AFUE Fan Atomized Burner w/Two-stage Modulation	518.13	138.25	37.77	76.30	770.45	151.65	2,139.89	539.00	110.44
4.1	83% AFUE-Increased HXArea	386.82	132.46	37.03	71.70	628.00	9.20	1,856.36	834.50	110.44
4.1.1	83% AFUE Interrupted Ignition	403.32	132.46	37.03	71.70	644.50	25.70	1,899.20	834.50	110.44
4.2	83% AFUE Fan Atomized Burner w/Two-stage Modulation	519.82	138.46	37.77	76.70	772.74	153.94	2,144.44	834.50	110.44
5.1	84% AFUE-Increased HXArea	388.50	132.46	37.03	71.70	629.68	10.88	1,859.71	1,130.00	110.44
5.1.1	84% AFUE Interrupted Ignition	405.00	132.46	37.03	71.70	646.18	27.38	1,892.55	1,130.00	110.44
5.2	84% AFUE Fan Atomized Burner w/Two-stage Modulation	521.50	138.46	37.77	76.70	774.42	155.62	2,147.79	1,130.00	110.44
6.1	85% AFUE-Increased HXArea	393.56	132.46	37.03	71.70	634.73	15.93	1,869.77	1,425.50	110.44
6.1.1	85% AFUE Fan Atomized Burner w/Two-stage Modulation	410.06	132.46	37.03	71.70	651.23	32.43	1,902.61	1,425.50	110.44
6.2	85% AFUE Fan Atomized Burner w/Two-stage Modulation	526.56	138.46	37.77	76.70	779.47	160.67	2,157.85	1,425.50	110.44

Table E.1.8 Energy and Economics Table for Oil-Fired Furnaces

ID	Efficiency Levels & Design Options	Energy Use Data			Summary Economics		
					Total Costs		
		BOH	Fuel	Electric	Total Installed	Total Operating	Simple Payback
		hr	Mbtu/yr	kWh/yr	\$	\$/yr	years
0	78% AFUE-Baseline	944	99.09	1,026	2,377	1,290	
1	80% AFUE-Increased HXArea	921	96.69	1,001	2,381	1,262	0.1
2.1	81% AFUE-Increased HXArea	910	95.54	989	2,387	1,248	0.2
2.1.1	81% AFUE Interrupted Ignition	921	96.66	727	2,410	1,238	0.6
2.2	81% AFUE Fan Atomized Burner w/Two-stage Modulation	897	94.21	886	2,676	1,225	4.6
3.1	82% AFUE-Increased HXArea	899	94.41	977	2,391	1,234	0.2
3.1.1	82% AFUE Interrupted Ignition	910	95.50	718	2,424	1,225	0.7
3.2	82% AFUE Fan Atomized Burner w/Two-stage Modulation	887	93.12	876	2,679	1,212	3.9
4.1	83% AFUE-Increased HXArea	889	93.31	966	2,691	1,221	4.6
4.1.1	83% AFUE Interrupted Ignition	899	94.38	710	2,724	1,212	4.4
4.2	83% AFUE Fan Atomized Burner w/Two-stage Modulation	877	92.05	866	2,979	1,199	6.6
5.1	84% AFUE-Increased HXArea	878	92.24	955	2,990	1,208	7.5
5.1.1	84% AFUE Interrupted Ignition	888	93.28	701	3,023	1,199	7.1
5.2	84% AFUE Fan Atomized Burner w/Two-stage Modulation	867	91.00	856	3,278	1,187	8.7
6.1	85% AFUE-Increased HXArea	868	91.19	944	3,295	1,196	9.8
6.1.1	85% AFUE Fan Atomized Burner w/Two-stage Modulation	878	92.20	693	3,328	1,186	9.2
6.2	85% AFUE Fan Atomized Burner w/Two-stage Modulation	857	89.98	846	3,583	1,174	10.4

Table E.1.9 Cost Table for Gas Boilers

ID	Efficiency Levels & Design Options	Cost Data								
		Manufacturer Costs (per unit)						Consumer Costs		
		Material	Labor	Transportation	Overhead	Total	Incremental	Retail	Installation	Maintenance
		\$	\$	\$	\$	\$	\$	\$	\$	\$
0	80% AFUE-Baseline	378.95	63.53	32.10	39.81	514.40		1,527.94	1,544.14	39.05
1.1	81% AFUE-Improved Heat Transfer Coef & Electronic Ignition	409.79	63.53	32.10	39.81	545.24	30.84	1,589.32	1,544.14	39.05
1.2	81% AFUE Two stage Modulation + Induced Draft	465.97	66.93	33.06	45.31	611.28	96.88	1,720.77	1,544.14	48.81
2.1	82% AFUE-Improved Heat Transfer Coef & Electronic Ignition	416.74	63.53	32.10	43.06	555.43	41.04	1,160.61	1,640.70	39.05
2.1	82% AFUE Two stage Modulation + Induced Draft	472.92	66.93	33.06	48.56	621.47	107.08	1,741.06	1,640.70	48.81
3.1	83% AFUE-Improved Heat Transfer Coef & Electronic Ignition	425.16	63.53	32.10	43.06	563.85	49.45	1,626.36	1,833.82	39.05
3.2	83% AFUE Two stage Modulation + Induced Draft	481.34	66.93	33.06	48.56	629.89	115.49	1,757.81	1,833.82	48.81
4.1	84% AFUE-Improved Heat Transfer Coef & Electronic Ignition	430.43	63.53	32.10	43.36	569.42	55.03	1,637.46	1,809.68	39.05
4.2	84% AFUE Two stage Modulation + Induced Draft	486.60	66.93	33.06	48.86	635.46	121.07	1,768.90	1,809.68	48.81
5.1	85% AFUE-Improved Heat Transfer Coef & Electronic Ignition	435.69	63.53	32.10	43.36	574.69	60.29	1,647.94	2,183.85	39.05
5.2	85% AFUE Two stage Modulation + Induced Draft	491.87	66.93	33.06	48.86	640.73	126.33	1,779.38	2,183.85	48.81
6	86% AFUE	500.81	73.06	32.92	47.31	654.10	139.70	1,806.00	2,727.00	39.05
7	91% AFUE	757.90	63.53	32.10	39.81	893.35	378.95	2,282.18	2,145.00	48.81
8	99% AFUE	1,094.31	94.98	76.81	92.72	1,358.81	844.41	3,208.62	2,145.00	48.81

Table E.1.10 Energy and Economics Table for Gas Boilers

ID	Efficiency Levels & Design Options	Energy Use Data			Summary Economics		
					Total Costs		
		BOH	Fuel	Electric	Total Installed	Total Operating	Simple Payback
		hr	Mbtu/yr	kWh/yr	\$	\$/yr	years
0	80% AFUE-Baseline	916	100.06	134	3,072	894	
1.1	81% AFUE-Improved Heat Transfer Coef & Electronic Ignition	937	98.34	161	3,133	881	5.0
1.2	81% AFUE Two stage Modulation + Induced Draft	931	97.74	168	3,265	887	27.6
2.1	82% AFUE-Improved Heat Transfer Coef & Electronic Ignition	925	97.14	159	3,250	871	7.9
2.1	82% AFUE Two stage Modulation + Induced Draft	920	96.56	166	3,382	876	18.1
3.1	83% AFUE-Improved Heat Transfer Coef & Electronic Ignition	914	95.98	157	3,460	861	11.9
3.2	83% AFUE Two stage Modulation + Induced Draft	909	95.41	164	3,592	867	19.3
4.1	84% AFUE-Improved Heat Transfer Coef & Electronic Ignition	903	94.84	155	3,447	851	8.9
4.2	84% AFUE Two stage Modulation + Induced Draft	898	94.29	162	3,579	857	13.8
5.1	85% AFUE-Improved Heat Transfer Coef & Electronic Ignition	893	93.73	153	3,832	842	14.7
5.2	85% AFUE Two stage Modulation + Induced Draft	888	93.19	160	3,963	848	19.4
6	86% AFUE	882	92.65	151	4,533	832	23.9
7	91% AFUE	1001	105.10	172	4,427	949	-24.5
8	99% AFUE	920	96.64	158	5,354	876	133.7

Table E.1.11 Cost Table for Oil-Fired Boilers

ID	Efficiency Levels & Design Options	Cost Data								
		Manufacturer Costs (per unit)						Consumer Costs		
		Material	Labor	Transportation	Overhead	Total	Incremental	Retail	Installation	Maintenance
		\$	\$	\$	\$	\$	\$	\$	\$	\$
0	80% AFUE	512.61	50.20	39.80	43.05	645.67		1,917.87	1,450.00	110.44
1.1	81% AFUE-Increased HXArea	513.60	52.36	39.80	43.80	649.57	3.90	1,925.63	1,450.00	110.44
1.2	81% AFUE Interrupted Ignition	530.10	52.36	39.80	43.80	666.07	20.40	1,958.48	1,450.00	110.44
2.1	82% AFUE-Increased HXArea	514.60	54.52	39.80	44.55	653.48	7.81	1,933.40	1,450.00	110.44
2.1.1	82% AFUE Interrupted Ignition	531.10	54.52	39.80	44.55	669.98	24.31	1,966.25	1,450.00	110.44
2.2	82% AFUE Fan Atomized Burner w/Two-stage Modulation	647.60	60.52	40.60	49.55	798.27	152.60	2,221.60	1,450.00	110.44
3.1	83% AFUE-Increased HXArea	515.59	56.68	39.80	45.30	657.38	11.71	1,941.17	1,450.00	110.44
3.1.1	83% AFUE Interrupted Ignition	532.09	56.68	39.80	45.30	673.88	28.21	1,974.02	1,450.00	110.44
3.2	83% AFUE Fan Atomized Burner w/Two-stage Modulation	648.59	62.68	40.60	50.30	802.18	156.51	2,229.37	1,450.00	110.44
4.1	84% AFUE-Increased HXArea	516.59	58.84	39.80	46.05	661.28	15.62	1,948.94	1,757.50	110.44
4.1.1	84% AFUE Interrupted Ignition	533.09	58.84	39.80	46.05	677.78	32.12	1,981.79	1,757.50	110.44
4.2	84% AFUE Fan Atomized Burner w/Two-stage Modulation	649.59	64.84	40.60	51.05	806.08	160.41	2,237.14	1,757.50	110.44
5.1	85% AFUE-Increased HXArea	518.57	63.16	39.80	47.56	669.09	23.42	1,964.48	2,065.00	110.44
5.1.1	85% AFUE Interrupted Ignition	535.07	63.16	39.80	47.56	685.59	39.92	1,997.33	2,065.00	110.44
5.2	85% AFUE Fan Atomized Burner w/Two-stage Modulation	651.57	69.16	40.60	52.56	813.89	168.22	2,252.68	2,065.00	110.44
6.1	86% AFUE-Increased HXArea	520.56	63.16	39.80	47.56	671.08	25.41	1,968.44	2,372.50	110.44
6.1.1	86% AFUE Interrupted Ignition	537.06	63.16	39.80	47.56	687.58	41.91	2,001.28	2,372.50	110.44
6.2	86% AFUE Fan Atomized Burner w/Two-stage Modulation	653.56	69.16	40.60	52.56	815.88	170.21	2,256.63	2,372.50	110.44
7	90% AFUE	806.92	82.11	105.10	85.60	1,079.73	434.06	2,781.80	2,145.00	110.44
8	95% AFUE	1,281.53	82.11	40.17	85.60	1,489.41	843.74	3,597.20	2,145.00	110.44

Table E.1.12 Energy and Economics Table for Oil-Fired Boilers

ID	Efficiency Levels & Design Options	Energy Use Data			Summary Economics		
					Total Costs		
		BOH	Fuel	Electric	Total Installed	Total Operating	Simple Payback
		hr	Mbtu/yr	kWh/yr	\$	\$/yr	years
0	80% AFUE	992	138.87	408	3,368	1,678	
1.1	81% AFUE-Increased HXArea	980	137.17	403	3,376	1,659	0.4
1.2	81% AFUE Interrupted Ignition	983	137.66	287	3,408	1,655	1.7
2.1	82% AFUE-Increased HXArea	968	135.51	398	3,383	1,640	0.4
2.1.1	82% AFUE Interrupted Ignition	971	135.99	284	3,416	1,636	1.1
2.2	82% AFUE Fan Atomized Burner w/Two-stage Modulation	964	134.91	465	3,672	1,639	7.8
3.1	83% AFUE-Increased HXArea	956	133.89	393	3,391	1,622	0.4
3.1.1	83% AFUE Interrupted Ignition	960	134.36	280	3,424	1,618	0.9
3.2	83% AFUE Fan Atomized Burner w/Two-stage Modulation	952	133.31	459	3,679	1,621	5.5
4.1	84% AFUE-Increased HXArea	945	132.31	333	3,706	1,604	4.6
4.1.1	84% AFUE Interrupted Ignition	948	132.77	277	3,739	1,600	4.7
4.2	84% AFUE Fan Atomized Burner w/Two-stage Modulation	941	131.74	454	3,995	1,603	8.4
5.1	85% AFUE-Increased HXArea	934	130.77	384	4,029	1,587	7.2
5.1.1	85% AFUE Interrupted Ignition	937	131.21	274	4,062	1,583	7.2
5.2	85% AFUE Fan Atomized Burner w/Two-stage Modulation	930	130.21	449	4,318	1,586	10.3
6.1	86% AFUE-Increased HXArea	923	129.26	379	4,341	1,570	9.0
6.1.1	86% AFUE Interrupted Ignition	926	129.69	270	4,374	1,566	8.9
6.2	86% AFUE Fan Atomized Burner w/Two-stage Modulation	919	128.71	443	4,629	1,569	11.6
7	90% AFUE	883	123.56	363	4,927	1,505	9.0
8	95% AFUE	956	133.84	393	5,742	1,621	41.8