

# Characterization of Household Residential Energy Consumption Using a Housing Unit Archetype Framework

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# Introduction

- Understanding the energy efficiency of housing units is important for targeting conservation efforts.
- Type of construction, age, and size of a housing unit are expected to result in variation in household energy consumption patterns.

# Method

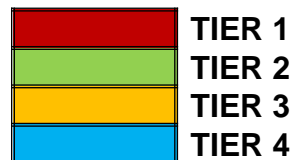
- County tax appraisal district data (housing unit characteristics) and local energy company data (source KBTUs in gas and electricity consumption for each unit in 2010) are used.
- Analysis restricted to dwellings occupied over the year. Housing units are distributed into a 100 cell grid (Table 1) based on vintage (year built) and size (square feet of living area).

SIZE DECILES	Before 1948	1948-1957	1958-1966	1967-1974	1975-1981	1982-1986	1987-1995	1996-2000	2001-2004	After 2004
<10 Percentile	[1] <792	[11] <816	[21] <927	[31] <975	[41] <1134	[51] <1078	[61] <1386	[71] <1354	[81] <1376	[91] <1458
10-19 Percentiles	[2] 792-911	[12] 816-934	[22] 928-1035	[32] 975-1117	[42] 1134-1292	[52] 1078-1237	[62] 1386-1598	[72] 1354-1568	[82] 1376-1604	[92] 1458-1661
20-29 Percentiles	[3] 912-1015	[13] 935-1019	[23] 1036-1151	[33] 1118-1223	[43] 1293-1419	[53] 1238-1367	[63] 1599-1807	[73] 1569-1794	[83] 1605-1801	[93] 1662-1854
30-39 Percentiles	[4] 1016-1111	[14] 1020-1107	[24] 1152-1261	[34] 1224-1321	[44] 1420-1538	[54] 1368-1472	[64] 1808-2048	[74] 1795-2074	[84] 1802-2071	[94] 1855-2101
40-49 Percentiles	[5] 1112-1207	[15] 1108-1204	[25] 1262-1367	[35] 1322-1447	[45] 1539-1681	[55] 1473-1601	[65] 2049-2237	[75] 2075-2228	[85] 2072-2255	[95] 2102-2311
50-59 Percentiles	[6] 1208-1314	[16] 1205-1308	[26] 1368-1493	[36] 1448-1580	[46] 1682-1803	[56] 1602-1765	[66] 2238-2399	[76] 2229-2423	[86] 2256-2427	[96] 2312-2520
60-69 Percentiles	[7] 1315-1441	[17] 1309-1435	[27] 1494-1651	[37] 1581-1723	[47] 1804-1957	[57] 1766-1953	[67] 2400-2575	[77] 2424-2653	[87] 2428-2675	[97] 2521-2745
70-79 Percentiles	[8] 1442-1631	[18] 1436-1605	[28] 1652-1858	[38] 1724-1927	[48] 1958-2174	[58] 1954-2211	[68] 2576-2855	[78] 2654-2959	[88] 2676-2968	[98] 2746-3030
80-89 Percentiles	[9] 1632-2063	[19] 1606-1928	[29] 1859-2207	[39] 1928-2236	[49] 2175-2516	[59] 2212-2621	[69] 2856-3282	[79] 2960-3325	[89] 2969-3352	[99] 3031-3440
90+ Percentile	[10] >2063	[20] >1928	[30] >2207	[40] >2236	[50] >2516	[60] >2621	[70] >3282	[80] >3325	[90] >3352	[100] >3440

# Consumption efficiency

- Examined as follows :
  1. The median source KBTUs for each of the 100 Vintage by Size categories were calculated.
  2. SKBTU's for the 100 were ranked from highest to lowest.
  3. Consumption categories were assigned as follows:
    - Tier 1 - Rank = 1-25: Lowest Efficiency
    - Tier 2 - Rank = 26-50: Moderate-Low Efficiency
    - Tier 3 – Rank = 51-75: Moderate-High Efficiency
    - Tier 4 – Rank = 76-100: Highest Efficiency

Size/Vintage	Before 1948	1948-1957	1958-1966	1967-1974	1975-1981	1982-1986	1987-1995	1996-2000	2001-2004	After 2004
<10 Percentile	1	2	3	5	11	10	22	17	30	49
10-19 Percentiles	4	6	7	13	25	21	46	44	47	73
20-29 Percentiles	8	9	15	20	35	28	56	53	62	81
30-39 Percentiles	14	12	24	27	42	34	63	66	71	92
40-49 Percentiles	16	18	31	33	47	40	76	75	77	95
50-59 Percentiles	19	23	37	38	55	43	78	79	85	96
60-69 Percentiles	26	29	45	52	59	50	82	84	87	97
70-79 Percentiles	32	35	56	58	61	60	83	86	93	98
80-89 Percentiles	39	41	67	65	68	64	88	91	94	100
90+ Percentile	51	53	72	74	68	70	89	80	90	99



# Housing Unit Examples



1  
1932  
942



2  
1977  
1,384



3  
1985  
1675



4  
2008  
3,117

# Refinement of Other Characteristics.

- The archetype grid can be further refined to include details.  
Using foundation types:
  - Pier and beam is less efficient across all tiers.
  - Pier and beam housing units have lower improvement values across all tiers.
  - In the first three tiers, based on median year built, pier and beam housing units are 23 or more years older than slab housing units.
  - In tier 4, housing units (built between 1987 and 2010), pier and beam is almost non-existent.



		Med. SKBTU per Square Foot	Med. GBA (Square Feet)	Med. Year Built	Med. Improvement Value, 2010
<b>TIER 1</b>	<b>Number</b>				
<b>All</b>	75,764	154.4	1,052	1958	\$40,770
<b>Slab</b>	44,266	149.6	1,081	1970	\$45,750
<b>Pier &amp; Beam</b>	31,475	163.3	992	1947	\$33,880
<b>TIER 2</b>					
<b>All</b>	75,934	124.5	1,460	1976	\$62,940
<b>Slab</b>	62,465	123.0	1,452	1980	\$78,070
<b>Pier &amp; Beam</b>	13,454	132.5	1,502	1945	\$64,250
<b>TIER 3</b>					
<b>All</b>	75,269	106.6	1,989	1979	\$86,740
<b>Slab</b>	70,797	106.1	1,970	1980	\$86,830
<b>Pier &amp; Beam</b>	4,806	116.1	2,384	1945	\$84,900
<b>TIER 4</b>					
<b>All</b>	79,180	90.3	2,624	2003	\$98,860
<b>Slab</b>	79,020	90.3	2,624	2003	\$98,890
<b>Pier &amp; Beam</b>	114	110.2	2,522	2003	\$90,655

# Refinement of Tiers

Subdivision of the four tiers based on additional vintage, size, and consumption details. Original four tiers subdivided into 16 archetypes based on:

1. Reducing the number and narrowing the range for vintages.
2. Deriving 'Small' and 'Large' size categories within each new vintage category.
3. Deriving 'High' and 'Low' SKBTU consumption categories by size and by vintage



# Conclusion

- Older, smaller houses are less energy efficient.
- An archetype framework has significant potential for targeting housing units with specific conservation efforts.