Awnings in Residential Buildings
The Impact on Energy Use and Peak Demand in Twelve U.S. Cities

Version 2.1 Summary

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Summary

The Benefits of Awnings

Awnings have advantages that contribute to more sustainable buildings. First, awnings result in cooling energy savings by reducing direct solar gain through windows. This directly reduces the impact of global warming from greenhouse gas emissions. A second benefit is that peak electricity demand is also reduced by awnings potentially resulting in reduced mechanical equipment costs. Reduced peak demand may also result in energy cost savings in the future if residential customers are charged higher rates during peak periods. Another outcome of peak demand reduction is the overall savings to utility companies and the public from a decreased need to build new generating capacity.

Photo courtesy PAMA.

Cooling Energy Savings and Peak Demand Reduction

Tables 1 and 2 show the impact of awnings on reducing cooling energy and peak demand in twelve U.S. cities with different climates. The cities are listed starting with the lowest cooling energy use (Seattle) up to the highest (Phoenix). For each city, results are shown for two typical houses. The first house has windows equally distributed on all four orientations while the second house has 80 percent of the windows facing west (the case with the highest cooling energy use from heat gain). The results in Tables 1 and 2 represent the best case for savings when awnings are applied to clear double-glazed windows and operated seasonally (details appear in the full report).

Table 1 shows cooling energy savings in all cities for all orientations, while Table 2 shows peak demand savings in most cities. In all cases, the cooling energy and peak demand savings from awnings are greater in the house with predominately west-facing windows. The highest percentage savings do not necessarily produce the highest actual savings. This occurs because some of the warmer cities with lower percentage savings have greater actual cooling energy and peak demand savings than colder climate cities with higher percentage savings and lower actual savings. Surprisingly, there can be little or no peak demand savings from awnings in some hot, humid cities. This is due to climatic variations that influence whether peak demand is driven more by solar gain through windows or by factors such as temperature and humidity. It is important to remember that these results are for a 2000 sq ft house and should be interpolated for larger houses. In addition, the energy prices may rise in the future increasing the savings and shortening the payback for investing in awnings.

Tables 3 and 4 show more extensive set of impacts from awnings for two cities: a predominantly cold climate (Boston) and a predominantly hot climate (Phoenix). Window types shown are clear double glazing, high-solar-gain low-E glazing, and low-solar-gain low-E glazing. Shading conditions include: no shading, awnings deployed 12 months a year, and awnings deployed in the summer only.

Cold Climate Impacts

Table 3 shows the impact of awnings on a typical house in Boston, Massachusetts, a predominantly cold climate. The impact varies depending on the type of window glazing and whether the awnings are in place 12 months per year or only in the summer.

For a house with windows equally distributed on the four sides, Table 3 shows the annual heating and cooling energy use and the peak electricity demand for each combination of glazing and shading condition. Table 3 also shows the impact on the total cost of heating and cooling. In each case, the table shows the percent savings compared to the unshaded condition.

As shown in Table 3, the awnings reduce the cooling energy 23–24 percent compared to a completely unshaded case. The actual savings are greater with the clear glass (A) and less with the low-solar-gain low-E glass (C). Because awnings block passive solar gain in winter, heating energy increases by 6–9 percent if the awnings remain in place 12 months a year. By removing or retracting the awnings in winter while keeping them in place in the

TABLE 1: SUMMARY OF AWNING IMPACTS ON COOLING ENERGY IN TWELVE U.S. CITIES

CITY	EQUAL WINDOW ORIENTATION				MOSTLY WEST WINDOW ORIENTATION			
	Cooling Energy No Awnings (kWh)	Cooling Energy With Awnings (kWh)	Cooling Energy Savings With Awnings (kWh)	Cooling Energy With Awnings % Savings	Cooling Energy No Awnings (kWh)	Cooling Energy With Awnings (kWh)	Cooling Energy Savings With Awnings (kWh)	Cooling Energy With Awnings % Savings
Seattle	252	98	154	61%	358	110	248	69%
Boston	855	651	204	24%	965	677	288	30%
Minneapolis	1097	817	280	26%	1172	850	321	27%
Washington	1736	1534	202	12%	1822	1567	255	14%
Sacramento	1787	1083	704	39%	2196	1148	1048	48%
Albuquerque	1881	1297	584	31%	2168	1333	836	39%
St.Louis	2366	1970	396	17%	2614	2022	592	23%
Atlanta	2422	2126	296	12%	2618	2154	464	18%
Jacksonville	4270	3835	435	10%	4477	3875	602	13%
Houston	4459	4096	363	8%	4774	4022	752	16%
Miami	7151	6609	542	8%	7392	6644	748	10%
Phoenix	7438	5905	1533	21%	8122	6046	2076	26%

TABLE 2: SUMMARY OF AWNING IMPACTS ON PEAK DEMAND IN TWELVE U.S. CITIES

CITY	EQUAL WINDOW ORIENTATION				MOSTLY WEST WINDOW ORIENTATION			
	Peak Demand No Awnings (kW)	Peak Demand With Awnings (kW)	Peak Demand Savings With Awnings (kW)	Peak Demand With Awnings % Savings	Peak Demand No Awnings (kW)	Peak Demand With Awnings (kW)	Peak Demand Savings With Awnings (kW)	Peak Demand With Awnings % Savings
Seattle	2.94	1.79	1.16	39%	4.00	2.06	1.95	49%
Boston	2.66	2.08	0.57	21%	3.74	2.23	1.51	40%
Minneapolis	2.86	2.59	0.28	10%	3.88	2.63	1.25	32%
Washington	3.60	3.50	0.11	3%	4.68	3.52	1.16	25%
Sacramento	3.51	2.75	0.75	21%	4.62	2.83	1.79	39%
Albuquerque	2.66	2.22	0.45	17%	3.93	2.25	1.68	43%
St.Louis	3.87	3.26	0.61	16%	4.95	3.33	1.62	33%
Atlanta	3.12	3.00	0.16	5%	3.80	3.00	0.83	22%
Jacksonville	3.41	3.46	-0.05	-1%	4.48	3.47	1.00	23%
Houston	3.43	3.25	0.18	5%	4.25	3.11	1.14	27%
Miami	3.39	3.38	0.00	0%	4.00	3.39	0.62	15%
Phoenix	5.55	4.85	0.70	13%	7.00	4.88	2.15	31%

Note: The annual energy performance figures shown here were generated using RESFEN for a typical (new construction) 2000 sq ft house with 300 sq ft of window area. In the first case, the windows are equally distributed on all four sides of the house. Where windows are predominately on the west side, the distribution is 240 sq ft on that side and 20 sq ft on the others. Clear double glazed windows are used in all cases. For all cities, the awning deployment shown is either a 12-month or summer only condition, whichever produces the best result. RESFEN is a computer program for calculating the annual cooling and heating energy use and costs due to window selection. It is available from Lawrence Berkeley National Laboratory (windows.lbl.gov/software/resfen)

summer, the lowest total energy use is achieved.

The total cost of heating and cooling is about equal in Boston when awnings are only used in the summer, but the total cost is increased if they remain in place 12 months a year.

Table 3 also shows that awnings reduce peak electricity demand by 17–22 percent in Boston. This may contribute to the ability to downsize the mechanical cooling system. The actual reduction is greater with the clear glass (A).

Hot Climate Impacts

Table 4 shows the impact of awnings on a typical house in Phoenix, Arizona with different orientation conditions. The same window orientation, window types, and shading conditions used for Boston are applied in Phoenix.

In Phoenix, the awnings reduce the cooling energy 14–20 percent compared to a completely unshaded case. As in Boston, because awnings block passive solar gain in winter, heating energy increases if the awnings remain in place 12 months a year. Of course, the relative importance of the heating versus the cooling season impacts varies by climate. In predominantly warm climates like Phoenix, the impact of awnings on reducing passive solar gain is less of a concern.

The total cost of heating and cooling is reduced 13–18 percent in Phoenix when awnings are only used in the summer. Table 4 also shows that awnings reduce peak electricity demand by 9–12 percent in Phoenix, potentially contributing to the ability to downsize the mechanical cooling system. The actual savings are greater with the clear glass (A) and less with the low-solar-gain low-E glass (C).

In comparing Tables 3 and 4, it is clear that the impacts of awnings are different depending on the building location and whether the awnings are deployed year-round or only in the summer. A very important consideration in assessing the benefits of awnings is window orientation. A house in any climate with the windows predominantly facing to the east, south, and west will have greater cooling energy use and cooling peak demand than the equal orientation case. This is particularly true with peak demand in the west orientation. Generally, this means energy and cost savings from using awnings is greater with predominantly east, south, and west orientations than when windows are equally distributed. Specific energy and cost savings multiple orientation conditions can be found in the full report.

TABLE 3: IMPACT OF AWNINGS ON A HOUSE—BOSTON, MASSACHUSETTS

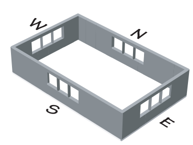
WINDOW	AWNING	COOLING Energy (kWh)	COOLING Energy Saved	COOLING Energy % Saved	HEATING Energy (MBTU)	HEATING Energy Saved	HEATING Energy % Saved	HEAT+COOL Cost ($)	HEAT+COOL Cost Saved	HEAT+COOL Cost % Saved	COOLING PEAK Peak (kW)	COOLING PEAK Peak Saved	COOLING PEAK Peak % Saved
A	none	855	–	–	68.1	–	–	$1,254	–	–	2.66	–	–
A	12 month	651	204	23.8%	74.4	-6.2	-9.1%	$1,319	-$65	-5.2%	2.08	0.57	21.5%
A	summer	651	204	23.8%	70.3	-2.1	-3.1%	$1,253	$1	0.1%	2.08	0.57	21.5%
B	none	822	–	–	63.3	–	–	$1,170	–	–	2.54	–	–
B	12 month	631	191	23.2%	69.0	-5.7	-9.0%	$1,228	-$58	-5.0%	1.99	0.55	21.6%
B	summer	631	191	23.2%	65.1	-1.8	-2.9%	$1,166	$4	0.4%	1.99	0.55	21.6%
C	none	449	–	–	70.4	–	–	$1,220	–	–	1.90	–	–
C	12 month	343	107	23.7%	74.3	-3.9	-5.5%	$1,264	-$44	-3.6%	1.57	0.33	17.3%
C	summer	343	107	23.7%	72.1	-1.7	-2.4%	$1,228	-$8	-0.7%	1.57	0.33	17.3%

TABLE 4: IMPACT OF AWNINGS—PHOENIX, ARIZONA

WINDOW	AWNING	COOLING Energy (kWh)	COOLING Energy Saved	COOLING Energy % Saved	HEATING Energy (MBTU)	HEATING Energy Saved	HEATING Energy % Saved	HEAT+COOL Cost ($)	HEAT+COOL Cost Saved	HEAT+COOL Cost % Saved	COOLING PEAK Peak (kW)	COOLING PEAK Peak Saved	COOLING PEAK Peak % Saved
A	none	7438	–	–	5.4	–	–	$992	–	–	5.55	–	–
A	12 month	5905	1533	20.6%	7.6	-2.1	-39.0%	$829	$163	16.4%	4.85	0.70	12.6%
A	summer	6011	1428	19.2%	5.5	-0.1	-1.1%	$816	$176	17.8%	4.85	0.70	12.6%
B	none	7171	–	–	4.8	–	–	$950	–	–	5.33	–	–
B	12 month	5739	1432	20.0%	6.6	-1.9	-38.9%	$796	$154	16.2%	4.67	0.66	12.4%
B	summer	5838	1333	18.6%	4.8	0.0	-0.2%	$785	$165	17.4%	4.67	0.66	12.4%
C	none	5708	–	–	6.3	–	–	$789	–	–	4.60	–	–
C	12 month	4837	870	15.2%	8.1	-1.8	-28.0%	$704	$85	10.8%	4.18	0.41	9.0%
C	summer	4884	824	14.4%	6.5	-0.1	-2.1%	$689	$101	12.7%	4.18	0.41	9.0%

	GLAZING	FRAME	U-FACTOR	SHGC
A	Double, Clear	Wood/vinyl	0.49	0.56
B	Double, High-solar-gain Low-E	Wood/vinyl	0.37	0.53
C	Double, Low-solar-gain Low-E	Wood/vinyl	0.34	0.30

Note: The annual energy performance figures shown here were generated using RESFEN for a typical (new construction) 2000 sq ft house with 300 sq ft of window area. All cases in this report assume that there are no other shading devices such as overhangs or blinds and that the house is not shaded by trees or other buildings.



The costs shown here are annual costs for space heating and space cooling only and thus will be less than total utility bills. Costs for lights, appliances, hot water, cooking, and other uses are not included in these figures. The mechanical system uses a gas furnace for heating and air conditioning for cooling. Electricity costs used in the analysis are $0.18 per kWh in Boston and $0.12 per kWh per in Phoenix. Natural gas costs used in the analysis are $16.20 per MBTU in Boston and $12.84 per MBTU in Phoenix. These figures are based on 25 year projected average costs for electricity during the cooling season and for natural gas during the heating season. All data is provided by the Energy Information Administration (www.eia.doe.gov). RESFEN is a computer program for calculating the annual cooling and heating energy use and costs due to window selection. It is available from Lawrence Berkeley National Laboratory (windows.lbl.gov/software/resfen).

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Efficient Windows Collaborative Web Site: www.efficientwindows.org