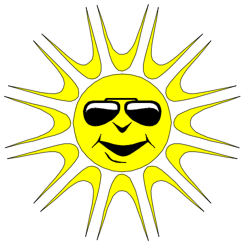
From the Building Energy Simulation User News, Spring 1997 – Vol 18, No. 1



Does It Matter Which Weather Data You Use in Energy Simulations? [1]

By
Drury B. Crawley, U.S. Department of Energy
and
Y. Joe Huang, Lawrence Berkeley National Laboratory

Synopsis

Users of energy simulation programs often have a wide variety of weather data from which to choose—from locally recorded, measured data to *typical* data sets. Using a prototype building, the influence of locally measured weather data and typical weather data sets on annual energy consumption, demand, and costs are compared.

Abstract

Users of energy simulation programs often have a variety of weather data from which to choose–from locally recorded, measured weather data to pre-selected 'typical' years–a bewildering range of options. In the last two years, several organizations have developed new typical weather data sets: WYEC2, TMY2, CWEC, and CTZ2. Unfortunately, neither how these new data influence energy simulation results nor how they compare to existing typical data sets or actual weather data is well documented.

In this paper, we present results from the DOE-2.1E hourly energy simulation program for a prototype office building as influenced by local measured weather data for multiple years and several weather data sets for a set of North American locations. We compare the influence of the various weather data sets on simulated annual energy use and energy costs. Statistics for temperature, solar radiation, and heating and cooling degree days for the different locations and data sets are also presented. Where possible, we explain the variation relative to the different designs used in developing each data set. We also show the variation inherent in actual weather data and how it influences simulation results. Finally, based on these results, we answer the question—does it really matter which weather data you use?

Introduction

The American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE), National Renewable Energy Laboratory (NREL), WATSUN Simulation Laboratory, and California Energy Commission (CEC) have all recently released updated typical weather data sets to use for simulating building energy performance: WYEC2, TMY2, CWEC, and CTZ2, respectively. Each designed their data sets to meet a particular need. ASHRAE designed the WYEC2 data set to represent typical weather patterns. NREL updated the TMY2 data sets to represent the most recent period of record available for work that requires insolation data. WATSUN Simulation Laboratory created the CWEC weather data sets for use by the National Research Council Canada in developing and complying with their new National Energy Code for Buildings. The CEC wanted to update their CTZ weather data for California Title 24 energy standards, as well as make them more representative of` average conditions within each climate region. All groups intended their weather data sets to be usable with energy simulation programs.

[1] *Presented at the ACEEE 1996 Summer Study on Energy Efficiency in Buildings, 25-31 August 1996, Asilomar Conference Center, Pacific Grove, California.*

A recent study [HAB 95] compared measured weather data in calibrated DOE-2 simulations versus TMY data. The four weather data sets (WYEC2, TMY2, CWEC, and CTZ2) were each developed with controlled methodologies; a specific method was used to determine which data from the actual weather data period of record would be used. These methods did not include evaluating the impact that the new data might have on energy simulation results nor how the data sets compare to actual weather data or other existing typical data sets. In this paper, we demonstrate these impacts for the TMY2 and WYEC2 data sets: comparison with actual weather data and energy simulation results.

Weather Data Sets

Over the past 20 years, several groups have developed weather data sets specifically designed for use in building energy simulations. One of the earliest, Test Reference Year (TRY) [NCDC 76], contains dry bulb, wet bulb, and dew point temperatures, wind direction and speed, barometric pressure, relative humidity, cloud cover and type, and a place holder for solar radiation, but no measured solar data. When used in building energy simulations, the simulation program typically estimates the amount of solar radiation based on the cloud cover and cloud type information available for the TRY location. Another weakness of TRY was the method used to select the data. The TRY data are from an actual historic year of weather, selected using a process whereby years in the period of record (~1948-1975) which had months with extremely high or low mean temperatures were progressively eliminated until only one year remained. This tended to result in a particularly mild year that, either by intention or default, excluded typical extreme conditions. TRY data are available for 60 locations in the U.S.

To deal with the limitations of TRY, particularly the lack of solar data, the National Climatic Data Center (NCDC) together with Sandia National Laboratory created a new data set, Typical Meteorological Year (TMY). TMY includes, in addition to the data contained in TRY, total horizontal and direct normal insolation data for 234 U.S. locations [NCDC 1981]. These solar data were measured for 26 of the locations and estimated from cloud cover and type for the other 208 locations. Data in this set consist of 12 months selected from an approximately 23-year period of record (~1952-1975—available data varied by location) to represent typical months. The method used is similar to that used for the TRY but is based on individual months rather than entire years. The TMY months were selected based on a monthly composite weighting of solar radiation, dry bulb temperature, dew point temperature, and wind velocity as compared to the long term distribution of those values. Months that were closest to the long term distribution were selected. Each resulting TMY data file contains months from different years.

In the late 1970s, the CEC developed a data set specifically for use in complying with the new Title 24 building energy regulations. They mapped the climate regions of the state, dividing it into 16 regions. Then they created a weather data set—California Thermal Zones (CTZ)—with a weather file for each region. The CTZ are based on the TMY format and several of the CTZ files were derived from a specific TMY location. In 1992, the CEC updated their CTZ data set, creating CTZ2 [CAL 1992], with data in ASHRAE's new WYEC2 format. In addition, the temperature profiles from the original CTZ data set were adjusted to make their monthly means correspond to the average monthly means of all the locations within each climate zone. More recently, the CEC developed a method to adjust the CTZ2 weather files to a specific location [CAL 1994]. Essentially, CEC modified the existing CTZ2 weather file to match another city's specific weather design day conditions [ASH 93].

In 1980, ASHRAE initiated a research project [CROW 80] to investigate whether weather data could be assembled to represent more typical weather patterns than either a single representative year or an assemblage of months. This weather data set—known as Weather Year for Energy

Calculations (WYEC) [ASH 85]—uses the TRY format and includes solar data (measured where available, otherwise calculated based on cloud cover and type). After the test case proved successful, ASHRAE commissioned development for an additional 50 locations for North America, which were completed in late 1983 [CROW 83]. In total, data for 51 North American locations were created (46 locations in the United States and 5 in Canada). More recently, ASHRAE sponsored research to update insolation models [PER 92] and updated the WYEC data set. The TMY format was used as the starting point and extended to include illumination data. The new format is known as WYEC2, for WYEC version 2.

In 1993, NREL created a new long-term insolation data set based on the 1961-1990 period of record known as the National Solar Radiation Data Base (NSRDB). In conjunction with the National Climatic Data Center (NCDC), they published a combined set of weather and solar data for 1961-1990. These data are known as Solar and Meteorological Surface Observational Network (SAMSON) [NCDC 93] and include 30 years of data for 239 locations—most of those in the original TMY data set. As with the TMY data set, only 56 locations have measured solar data for at least a portion of the 30-year period of record. For the remaining 183 locations, insolation values were calculated based on the Perez model [PER 92]. After completing this work, NREL worked with ASHRAE to update the 51 WYEC and 26 primary TMY weather files to create the WYEC2 data set [STO 95]. Separately, NREL updated the TMY data set based on the new period of record (1961-1990) available in SAMSON—creating the TMY2 data set [NREL 95].

In 1992, NRC Canada commissioned the WATSUN Energy Laboratory at the University of Waterloo to create a weather data set for Canadian locations. They used the long term data set developed by the Atmospheric Environment Service, Environment Canada, in a TMY methodology, formatting the resultant data set in ASHRAE's WYEC2 format. To date, data for approximately 40 locations have been created [WAT 92].

In Europe, a data set for European locations (European Test Reference Year) [CEC 95] has been created using a methodology similar to that used by NCDC to derive the TMY. Petrakis [PET 95] recommends procedures for generating Test Meteorological Years from observed data sets.

Simulation Methodology

For this paper, we simulated an office building using the DOE-2.1E hourly energy simulation program. The building model remained identical for all weather data sets, with HVAC equipment sizing based on design conditions in the ASHRAE *Handbook of Fundamentals* [ASH 93]. The structure used was a 48,000 ft^2, three-story office building: a typical, recent, envelope-dominated low-rise U.S. building.

For lighting, efficient 0.8 W/ft^2, T-8 fluorescent, 2-lamp, 2 x 4 fixtures with electronic ballasts and occupancy sensors were assumed. Office equipment was assumed at a level of 1.0 W/ft^2 for computers, laser printers, photocopiers, and facsimile machines. The building envelope assumed a 40% fenestration-to-wall ratio with glazing varying by location—primarily single-pane, tinted/reflective in southern locations, double-pane, tinted in northern locations. The assumed occupied outside air ventilation rate was 20 CFM/person. The air system simulated was a VAV reheat system with enthalpy-controlled outside air economizer. The central plant included 0.55 kW per ton centrifugal chillers and a 90% efficiency gas-fired boiler. Energy costs were calculated using current local utility rates.

Actual weather data (30-year period of record, 1961-1990) and typical weather data sets (TRY, TMY, TMY2, WYEC, and WYEC2) were used in the simulations. Five U.S. locations were selected in order to cover a range of typical climatic patterns: Los Angeles, Miami, Minneapolis, Seattle, and Washington, D. C. The maximum, average, median, and minimum of the 1961-1990 weather data for temperature, solar radiation, and heating and cooling degree days for the different locations along with the 99% (winter) and 2.5% (summer) design temperature values [ASH 93] are shown in Table 2. Similar statistics for typical weather data sets are also shown in Table 2. In the tables and the figures, WYEC2 (TMY) means WYEC2 data derived from original TMY.

Results
In Figures 1 through 5 the office building simulation results, using 30 years of actual weather data (1961-1990), are shown in terms of end-use energy performance and energy costs by fuel type for the five locations. As shown in the figures, locations that are heating-dominated (Minneapolis) or have a more balanced amount of heating and cooling (Seattle and Washington, D.C.) demonstrate a higher variation in energy use. Milder or cooling-dominated climates (Los Angeles and Miami) demonstrate less variation in energy use. Energy cost variations are somewhat dampened since monthly peak demands play an important part—not just normal hourly weather.

Table 1 summarizes the variability seen in Figures 1-5 (30 years of actual weather data). For each location, the average value, along with minimum and maximum percent change from that value, are shown for annual energy consumption, peak annual electrical demand, and annual energy costs.

Figures 6-10 compare the weather data sets results in terms of end-use energy performance and energy costs by fuel type for the five locations. Also shown are the maximum, average, and minimum for the simulations using the actual weather data for the 30-year period of record (Figures 1-5).

Summary and Conclusions
The range of energy consumption due to actual weather variation can be significant—as much as +7.0%/-11.0% from long-term average weather patterns for these five locations. The average variation in annual energy consumption due to weather variation is ±5%. Annual variation in weather mostly affects energy consumption in heating-dominated locations such as Minneapolis. Annual weather variations have the least impact on energy consumption in cooling-dominated locations such as Los Angeles and Miami. Where heating and cooling loads are more balanced, as in Seattle and Washington, the impact is more variable. The variation in energy consumption is similar to that reported [HAB 95] for measured and TMY weather data; results showed that the energy consumption values predicted by DOE-2 were consistently higher by 5 to 15% than the measured energy consumption.

As shown in Table 1, the range of peak electrical demand variation due to actual weather patterns is also significant—as much as +9.6%/-9.7% for these five locations. Variation in peak demand on average is ±6%—larger than that for energy consumption. Similar to energy consumption, the least variation is apparent in Miami, a cooling-dominated location. Unlike energy consumption, peak demand varies considerably more in Los Angeles, a location with relatively mild but variable weather conditions. Similar to Los Angeles, Seattle has higher variation in electric demand. Because the simulated building is gas-heated, electrical demand variation is less than that of energy consumption in heating-dominated climates such as Minneapolis. For Washington, peak electrical demand variability is somewhat less for than energy consumption.

Annual energy cost variations due to weather variation are significant but not as large as for energy consumption—as much as +3.6%/-4.4% from long-term average weather pattern for these five locations.

Variation in annual energy cost due to weather variation is on average ±3%. Similar to energy consumption, locations that are heating-dominated (Minneapolis) have greater variation than do locations that are more balanced in heating and cooling loads (Seattle and Washington) or that are cooling-dominated (Los Angeles and Miami). Since annual peak electrical demand charges are more constant, total electricity costs (and total energy costs) vary less overall than energy consumption or peak electrical demand.

The TRY data set varies the most from the average of the 30-year actual weather results. This is probably because each location has a specific year of data—no one year can represent the long-term typical weather patterns. In Figures 6-10, the results for the TRY data sets often vary the most from the average—higher and lower (except in more solar-dominated Los Angeles and Miami—solar data in the TRY case was estimated by DOE-2). In one case (Minneapolis) the annual energy costs for the TRY exceed the maximum for the 30-year actual weather data set.

As shown in Table 2, the TMY2/TMY data sets more closely match the 30-year actual weather solar insolation statistics and the WYEC2/WYEC data sets more closely match the design temperatures and degree days. In no cases do either the TMY2/TMY or WYEC2/WYEC perform consistently better. Either the design temperatures or the insolation vary significantly from the long-term average. There is also significant variation from the design temperatures for each location, some of which is attributable to the new period of record (1961-1990) for the TMY2 data and the 30-year actual weather data versus the older period of record (~1948-1975) for most of the other data sets (TRY, WYEC, WYEC2, and ASHRAE design temperatures). None of the methods for selecting typical weather data is consistently better than the others.

Recommendations
Users of energy simulation programs should avoid using TRY-type weather data. A more comprehensive method such as used for the TMY2 and WYEC2 data sets are more appropriate and will result in predicted energy consumption and energy costs that are closer to the long-term average. Newer data sets (TMY2 and WYEC2) should be used instead of the older TRY, TMY, or WYEC, as the newer data sets are based on improved solar models and more closely match the long-term average climatic conditions.

Since TMY2 data provide insolation that is closer to the long-term average than the other available data sets, TMY2 should be used in building energy simulations where insolation is critical to the results (for example in buildings that are daylit, have large window/wall ratios, or are poorly insulated). WYEC2 provides a closer match to long-term temperature patterns and should be used where those are important to building energy simulations.

The authors also have several recommendations for development of future weather data sets. The TMY2/TMY method appears to work well in most cases but the resultant files may need to be adjusted to match the long-term average statistics more closely—the mean of the 30-year period of record in this case. A second approach would be to create a typical weather file that has three years: typical (average), cold/cloudy, and hot/sunny. This would capture more than the average conditions and provide simulation results that identify some of the uncertainty and variability inherent in weather. Last, the method used in this paper needs to be attempted on a broader scale—more typical weather data sets and actual weather data. Also, it should be attempted with at least a residential-scale building and a smaller commercial building (<10,000 ft^2).

References

[ASH 85] American Society of Heating, Refrigerating, and Air-conditioning Engineers (ASHRAE). 1985. *Weather Year for Energy Calculations*. Atlanta, Georgia: ASHRAE.

[ASH 93] ASHRAE. 1993. *ASHRAE Handbook of Fundamentals*. Atlanta, Georgia

[CAL 92] California Energy Commission. 1992. *Climate Zone Weather Data Analysis and Revision Project*, P400-92-004. Sacramento, California: California Energy Commission.

[CAL 94] California Energy Commission. 1994. *The Adjustment of Title 24 Climate Zone Weather Data to Reflect Cities' ASHRAE Design Day Conditions*, Staff Report, 20 July 1994. Sacramento, California: California Energy Commission.

[CEC 85] Commission of the European Community. 1985. *Test Reference Years,* Weather data sets for computer simulations of solar energy systems and energy consumption in buildings, CEC, DG XII. Brussels, Belgium: Commission of the European Community.

[CROW 80] Crow, L.W. 1980. "Development of Hourly Data for Weather Year for Energy Calculations (WYEC), Including Solar Data, at 21 Weather Stations throughout the United States," *ASHRAE Transactions 1980,* V. 87, Pt. 1. Atlanta, Georgia: ASHRAE.

[CROW 83] Crow, L.W. 1983. *Development of Hourly Data for Weather Year for Energy Calculations (WYEC), Including Solar Data, at 29 Stations throughout the United States and 5 Stations in Canada,* ASHRAE Research Project RP364 Final Report, November 1983. Atlanta, Georgia: ASHRAE.

[HAB 95] Haberl, Jeff S., Doug J. Bronson, and Dennis L. O'Neal. 1995. "Impact of Using Measured Weather Data vs. TMY Weather Data in a DOE-2 Simulation," in *ASHRAE Transactions 1995*, V. 101, Pt. 2. Atlanta, Georgia: ASHRAE.

[NCDC 76] National Climatic Data Center (NCDC). 1976. *Test Reference Year (TRY)*, Tape Reference Manual, TD-9706, September 1976. Asheville, North Carolina: NCDC, U.S. Department of Commerce.

[NCDC 81] NCDC. 1981. *Typical Meteorological Year User's Manual, TD-9734, Hourly Solar Radiation—Surface Meteorological Observations*, May 1981. Asheville, North Carolina: NCDC, U.S. Department of Commerce.

[NCDC 93] NCDC. 1993. *Solar and Meteorological Surface Observation Network, 1961-1990, Version 1.0*, September 1993. Asheville, North Carolina: NCDC, U.S. Department of Commerce.

[NREL 95] National Renewable Energy Laboratory (NREL). 1995. *User's Manual for TMY2s (Typical Meteorological Years),* NREL/SP-463-7668, and *TMY2s, Typical Meteorological Years Derived from the 1961-1990 National Solar Radiation Data Base*, June 1995, CD-ROM. Golden, Colorado: NREL.

[PER 92] Perez, R. R., P. Ineichen, E.L. Maxwell, R.D. Seals, and A. Zelenka. 1992. "Dynamic Global-to-Direct Irradiance Conversion Models," *ASHRAE Transactions 1992*, V. 98, Pt. 1. Atlanta, Georgia: ASHRAE.

[PET 95] Petrakis, M. 1995. "Test Meteorological Years: Procedures for Generation of TMY from Observed Data Sets," in *Natural Cooling Techniques, Research Final Report, PASCOOL*, Alvarez et al, editors. Brussels, Belgium: Commission of the European Commission.

[STO 95] Stoffel, T. L. 1995. *Development of WYEC2 Data Files.* Golden, Colorado: NREL.

[WAT 92] WATSUN Simulation Laboratory. 1992. *Engineering Data Sets of Hourly Weather Observations in WYEC2 Format (WYEC2 Files) and Canadian Weather for Energy Calculations (CWEC Files), User's Manual*, 15 September 1992, prepared for Environment Canada Atmospheric Environment Service and National Research Council Canada. Waterloo, Ontario: WATSUN Simulation Laboratory, University of Waterloo.

[WIN 94] Winkelmann, F.C., W.F. Buhl, B. Birdsall, A. E. Erdem, and K. Ellington. 1994. *DOE-2.1E Supplement*, DE-940-11218. Lawrence Berkeley National Laboratory, Berkeley, California. Springfield, Virginia: National Technical Information Service.

Figure 1
Effect of Actual Weather Variation on Energy Consumption / Energy Costs in Los Angeles, CA

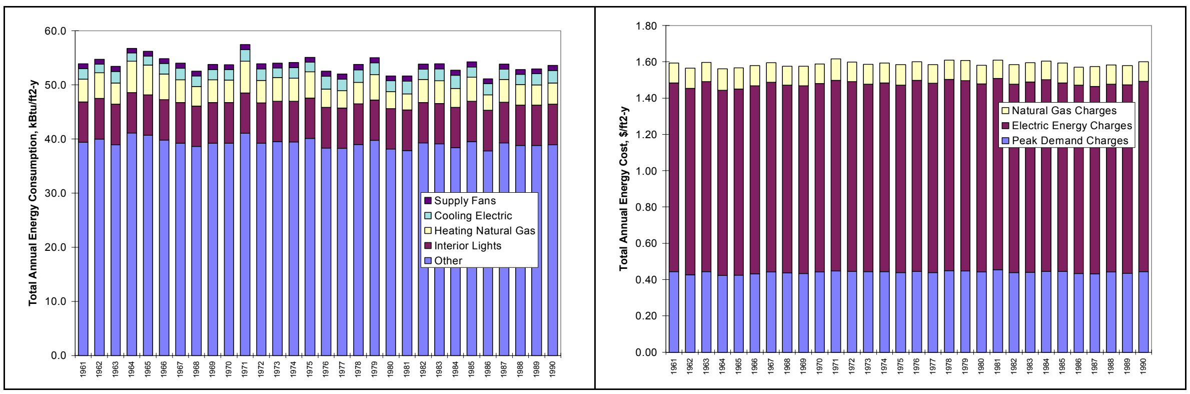


Figure 2
Effect of Actual Weather Variation on Energy Consumption / Energy Costs in Miami, FL

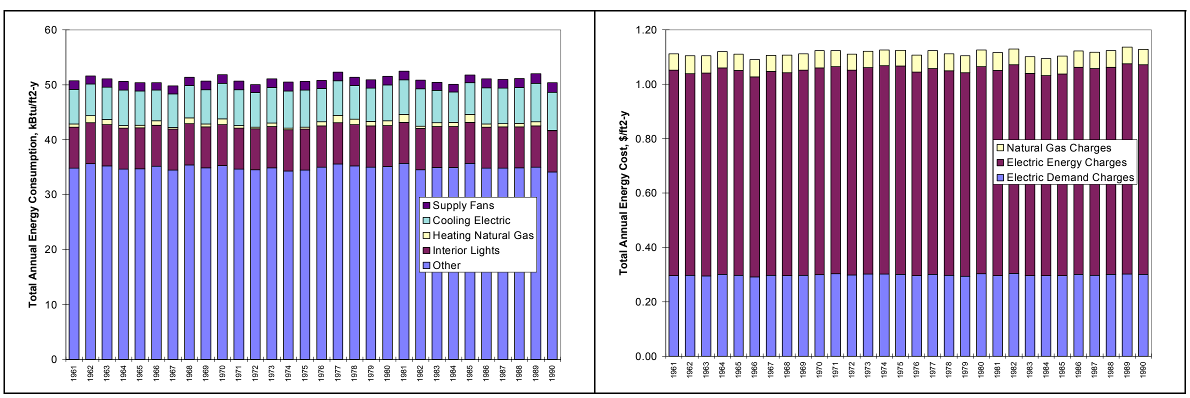


Figure 3
Effect of Actual Weather Variation on Energy Consumption / Energy Costs in Minneapolis, MN

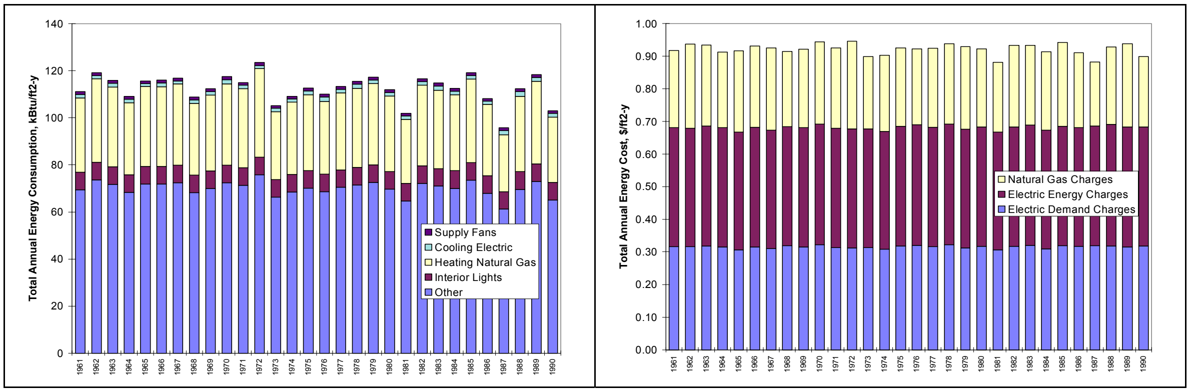


Figure 4
Effect of Actual Weather Variation on Energy Consumption / Energy Costs in Seattle, WA

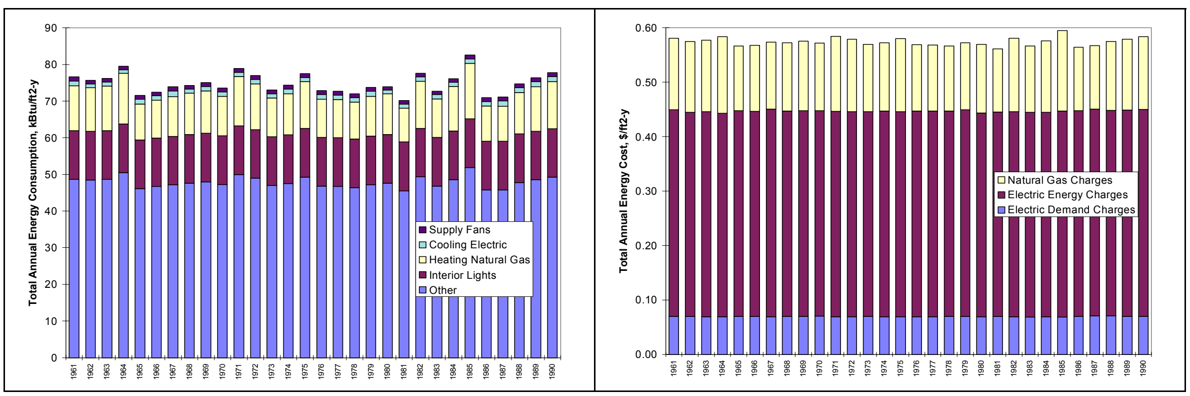


Figure 5
Effect of Actual Weather Variation on Energy Consumption / Energy Costs in Washington, D. C.

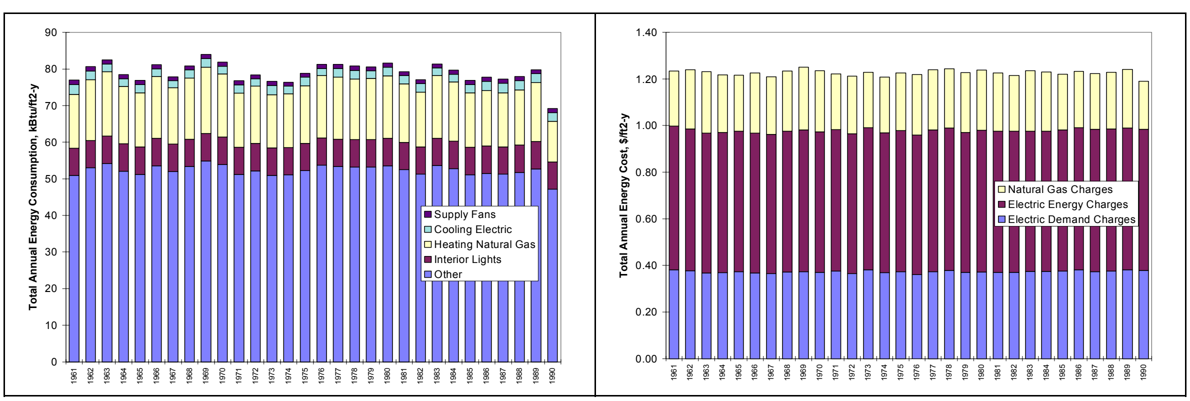


Figure 6

Comparison of Simulation Results in Los Angeles, CA. For Weather File Types and Actual Weather

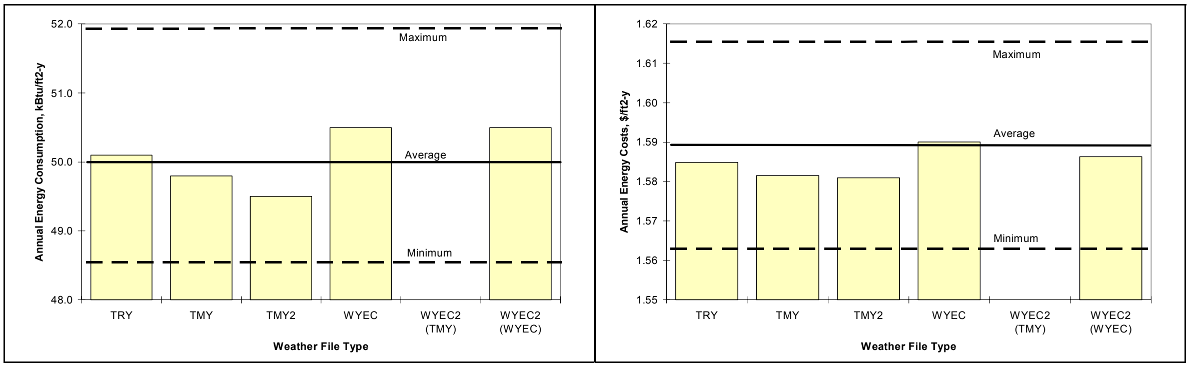


Figure 7
Comparison of Simulation Results in Miami, FL, for Weather File Types and Actual Weather

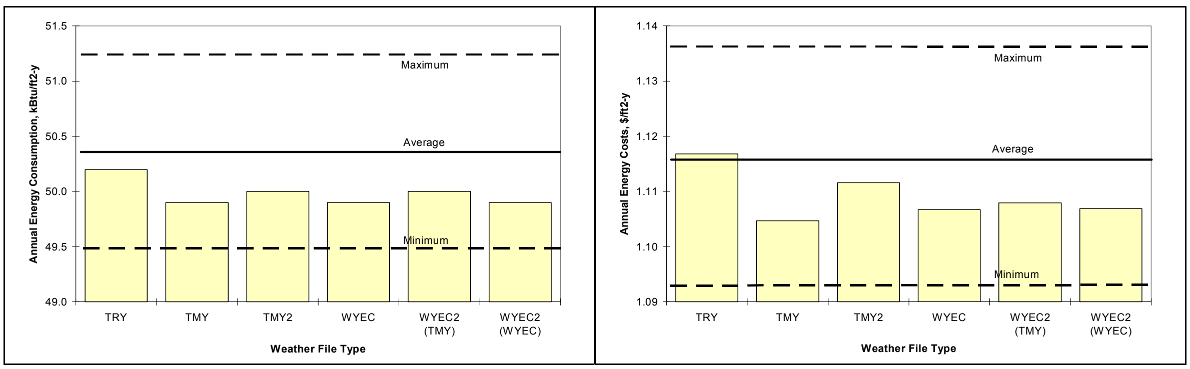


Figure 8
Comparison of Simulation Results in Minneapolis, MN, for Weather File Types and Actual Weather

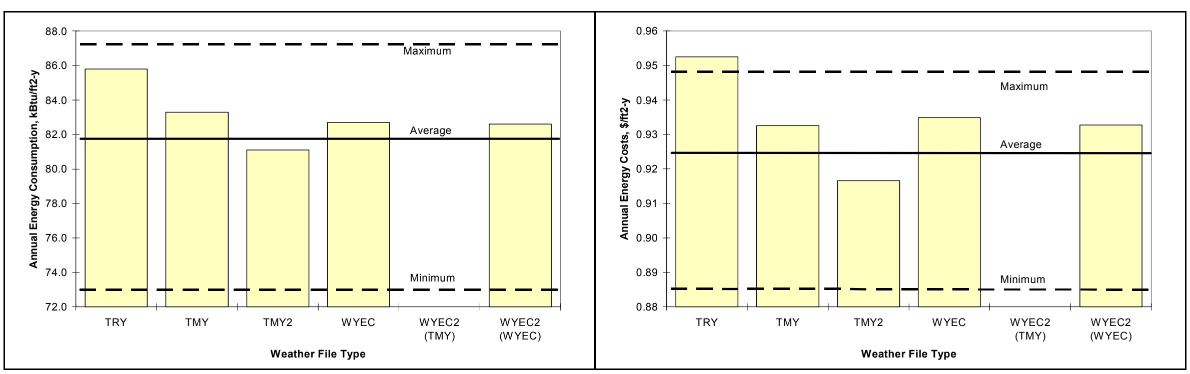


Figure 9
Comparison of Simulation Results in Seattle, WA, for Weather File Types and Actual Weather

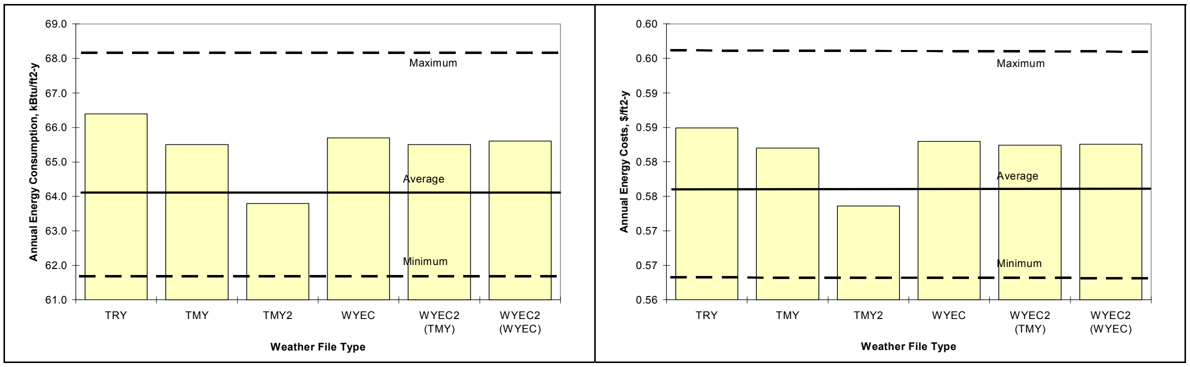


Figure 10
Comparison of Simulation Results in Washington, DC for Weather File Types and Actual Weather

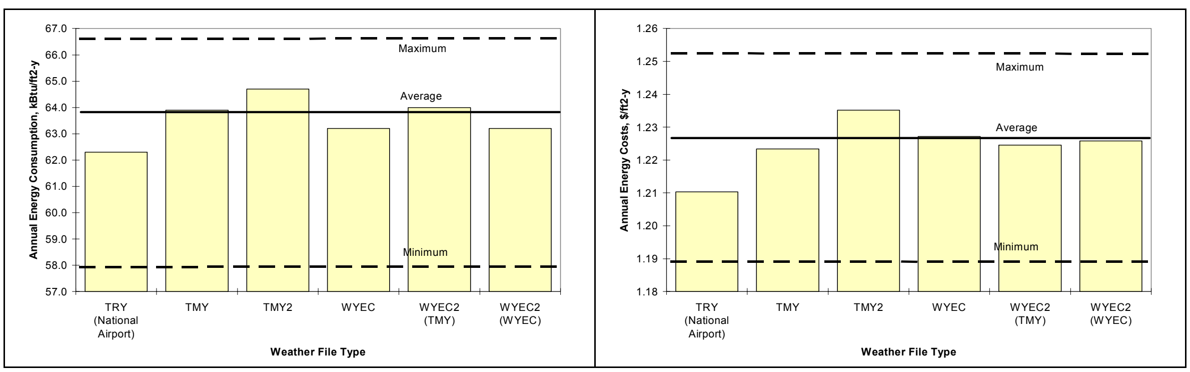


Table 1
Comparison of Variation in Energy Consumption, Demand, and Costs Due to Weather Variation

Location	**Average** (Min/Max -/+%)		
	Total Annual Energy Consumption, kBtu/ft²-y	**Annual Peak Electric Demand, kW**	**Total Annual Energy Costs, $/ft²-y**
Los Angeles, California	**49.9** (-3.0%/4.0%)	**197.0** (-9.1%/9.6%)	**1.59** (-1.7%/1.7%)
Miami, Florida	**50.3** (-1.8%/1.8%)	**224.9** (-2.5%/2.3%)	**1.11** (-2.1%/1.9%)
Minneapolis, Minnesota	**81.4** (-11.0%/7.0%)	**210.9** (-9.7%/4.4%)	**0.92** (-4.4%/2.6%)
Seattle, Washington	**63.9** (-3.9%/6.5%)	**215.6** (-6.8%/4.3%)	**0.58** (-2.3%/3.6%)
Washington, D. C.	**63.8** (-8.1%/4.3%)	**214.4** (-7.9%/3.7%)	**1.23** (-3.0%/2.0%)

Table 2
Comparison of Weather Statistics for 1961-90 Actual Weather and Weather File Types

Location	Statistic or File Type		Winter 99% Dry bulb Temperature	Summer 2-1/2% Dry bulb Temperature	Heating Degree Days, 65 F	Cooling Degree Days, 65 F	Direct Normal Solar	Horizontal Solar
Los Angeles	Design Temperature		41	80				
California		Maximum	47	84	1915.5	933.5	1694.8	1632.7
	1961-1990	Average	42.6	78.8	1401.6	591.7	1532.1	1568.1
		Median	42	78.5	1376.3	535.5	1546.4	1564.8
		Minimum	39	74	976.5	284.5	1365.2	1499.7
	TRY		42	78	1518.0	391.5	1331.5	1392.2
	TMY		42	78	1506.5	466.5	1693.7	1611.6
	TMY2		43	77	1291.0	469.5	1563.6	1579.4
	WYEC		41	77	1704.0	459.0	1662.6	1608.8
	WYEC2 (WYEC)		41	77	1704.0	459.0	1373.2	1553.6
Miami	Design Temperature		44	90				
Florida		Maximum	54	92	345.0	4741.0	1453.7	1630.9
	1961-1990	Average	44.4	89.4	190.5	4138.7	1254.0	1532.0
		Median	44.5	89.0	194.8	4119.5	1274.2	1531.5
		Minimum	37	87	17.5	3438.0	990.8	1344.4
	TRY		44	89	147.0	4262.5	863.7	1367.5
	TMY		43	89	188.5	4031.0	1231.7	1482.0
	TMY2		48	89	141.0	4126.5	1307.2	1557.2
	WYEC2 (TMY)		43	89	188.5	4032.5	1071.0	1477.5
	WYEC		42	89	227.0	4005.0	1047.6	1478.0
	WYEC2 (WYEC)		42	89	227.0	4005.0	1049.9	1470.2
Minneapolis	Design Temperature		-16	89				
Minnesota		Maximum	-5	95	9105.0	1124.5	1574.6	1343.9
	1961-1990	Average	-15.7	87.9	8002.9	695.9	1265.6	1234.0
		Median	-16.5	88.0	8077.3	688.3	1250.4	1228.7
		Minimum	-24	84	6435.0	401.0	1041.1	1167.2
	TRY		-25	90	8345.5	911.5	1069.0	1160.2
	TMY		-17	90	8095.0	759.5	1182.3	1169.6
	TMY2		-15	86	7985.5	634.0	1299.1	1257.0
	WYEC		-20	88	8070.5	750.5	1123.3	1170.8
	WYEC2 (WYEC)		-19	88	8070.0	750.5	1135.4	1161.4
Seattle	Design Temperature		21	80				
Washington		Maximum	31	86	5674.5	338.0	1106.6	1140.5
	1961-1990	Average	23.7	81.5	4927.7	162.9	932.5	1055.2
		Median	25.5	82.0	4844.8	167.8	947.4	1056.4
		Minimum	13	76	4338.0	52.0	664.3	1000.1
	TRY		27	84	5373.5	142.0	675.7	933.8
	TMY		24	81	5299.5	106.0	878.2	1031.8
	TMY2		29	80	4867.0	127.0	966.4	1061.5
	WYEC2 (TMY)		24	81	5295.5	106.0	878.8	1030.8
	WYEC		20	81	5222.5	97.0	916.5	1054.0
	WYEC2 (WYEC)		20	81	5222.5	97.0	908.1	1047.2
Washington, D. C.	Design Temperature		14	91				
(Dulles Airport)		Maximum	18	95	5538.0	1470.0	1367.4	1402.8
	1961-1990	Average	7.0	89.9	5017.3	1042.4	1173.7	1303.2
		Median	6.5	90.0	5034.8	1019.8	1172.3	1311.1
		Minimum	0	87	3993.0	766.5	1020.8	1177.4
	TRY (National Airport)		13	91	4112.5	1525.5	1025.0	1231.9
	TMY		7	90	4865.5	1054.0	1131.2	1215.3
	TMY2		8	89	5233.0	1044.0	1171.4	1300.5
	WYEC2 (TMY)		7	90	4865.5	1062.5	1023.2	1213.5
	WYEC		12	90	4236.0	1425.0	1000.0	1212.3
	WYEC2 (WYEC)		12	90	4236.0	1425.0	982.6	1201.7