DEERR2014* — Codes and Standards Update for the 2013-14 Cycle

** This version of the DEER update is now called as "DEER2014", with the referenced year indicating the first year the results are applicable. The draft version of this update was previously referred to as "DEER2013".*

11 February 2014

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1.0 Background

The DEER2014 update includes required Codes and Standards (C&S) changes that become effective in 2014 and will be applied to the 2013-14 portfolio cycle. The C&S updates that are most significant to the DEER include the California Title 20 Appliance Efficiency Regulations, the California Title 24 Building Energy Efficiency Standards, and the United States Code of Federal Regulations. These updates include the following:

- **2013 Title 20 Appliance Standards:** The standards updates came into effect on February 1, 2013, and apply to 23 appliances. Details can be found at http://www.energy.ca.gov/appliances/
- **2013 Title 24 Building Codes:** Building efficiency standards will become effective January 1, 2014. They include prescriptive measures, mandatory requirements and compliance options for residential and non-residential buildings. Details can be found at http://www.energy.ca.gov/title24/2013standards/index.html

The DEER2014 Update was developed based on the DEER2011 assumptions and methods, which are provided on the DEER website. The C&S changes that are taken into account for DEER2014 only impact ex ante parameter values for unit energy savings (UES) of kWh, kW, and therm. C&S updates lead to the following updates in simulation models:

1.1 Summary of Model Changes based on C&S Updates

Simulation Component	Description
HVAC measures	Code level efficiency changes
Lighting measures	Occupancy sensors assumed to be included in code update in some activity areas
Electric small storage and instantaneous DHW	Code level EF increased to fix error in specified Federal Code requirements
Weather Files for energy simulations	CTZ2 weather files replaced with CZ2010, as specified in the 2013 Title-24
Peak Demand Period definition	3-day heat wave selected based on new weather files

The Energy Star joint program of the U.S. Environmental Protection Agency and the U.S. Department of Energy, and the Consortium for Energy Efficiency (CEE) both develop minimum qualification savings levels that are commonly used to establish “above code” thresholds used in the EE portfolios. When C&S changes are adopted, the Energy Star and CEE qualifying levels usually change as well. For DEER measure values to be appropriate for application to deemed measures within the EE portfolios, the measure definitions must reflect the CEE and Energy Star thresholds planned for use.

1.2 Availability

This DEER2014 C&S update is available on the DEEResources.net database server as "deer2014". A new version of the database access tool "READI" is required to access the new database (available on the DEEResources.com web site). Within READI, connect to the database by using the Tools Menu "Change Database" and selecting the "DEER2014 Code Update". All updated measure definitions and energy impact records have the "Version" field set to DEER2014.

2.0 Updated HVAC Measures

2.1 Economizers and Two-speed fan controls on DX equipment

Under the 2013 Title-24 specifications, all single-zone direct-expansion cooling systems with a cooling capacity over 54 kBTUh require economizers; this threshold capacity has been lowered from 75 kBTUh.

The new Title-24 also lowered the minimum capacity of direct-expansion cooling equipment that require two speed fans. Starting on 1 January 2014, all packaged single-zone systems with a rated cooling capacity greater than 75 kBTUh (6.25 tons) must have two-speed fans with a low speed flow ratio of 66% of the high speed flow rate, and fan power not greater than 40% of maximum fan power at the lower flow rate . Two-speed fans are also required on all systems that have an economizer, with the two-speed fan operation used during economizer operation for systems less than 75 kBTU.

The two-speed fan and economizer requirements have led to new size ranges being defined for all of the single-zone direct-expansion cooling systems.

DEER2011			DEER2013		
Size Range	Economizer	2-speed Fan	Size Range	Economizer	2-speed Fan
<65 kBTUh	No	No	<55 kBTUh	No	No
			55 - 64 kBTUh	Yes	Yes
65 - 89 kBTUh	Yes	No	65 - 134 kBTUh	Yes	Yes
90- 134 kBTUh	Yes	No			
135 - 239 kBTUh	Yes	No[1]	135 - 239 kBTUh	Yes	Yes
240 - 759 kBTUh	Yes	No[1]	240 - 759 kBTUh	Yes	Yes
>= 760 kBTUh	Yes	No[1]	>= 760 kBTUh	Yes	Yes

Table 2.1.1. Single-zone DX cooling system specifications for economizer and fan speed

Note 1: 2008 Title-24 required two-speed fans for systems larger than 110 kBTUh after 1/1/2012. However, ***two-speed fans were not included with these cooling systems in DEER2011***. As a result, the DEER2011 energy impacts for these system types are greater than

can be expected for above-code savings (since both code and measure technologies are single-speed) and the impacts are less than can be expected for an early-retirement remaining-useful-life period (since the measure technology does not have two-speed fans).
Note 2: At this time, the version of DOE-2 used for this DEER update is not able to limit two speed operation to only the economizer mode which means, for units under 75 kBTU, above code savings will be underestimated.

The 2-speed fan requirement lowers the baseline HVAC energy use for most building types, and thus indirectly impacts the savings potential of many measures. For AC and HP efficiency tier measures, the two-speed fan requirement significantly reduces the energy use associated with the supply fan and reduces the above-code savings values.

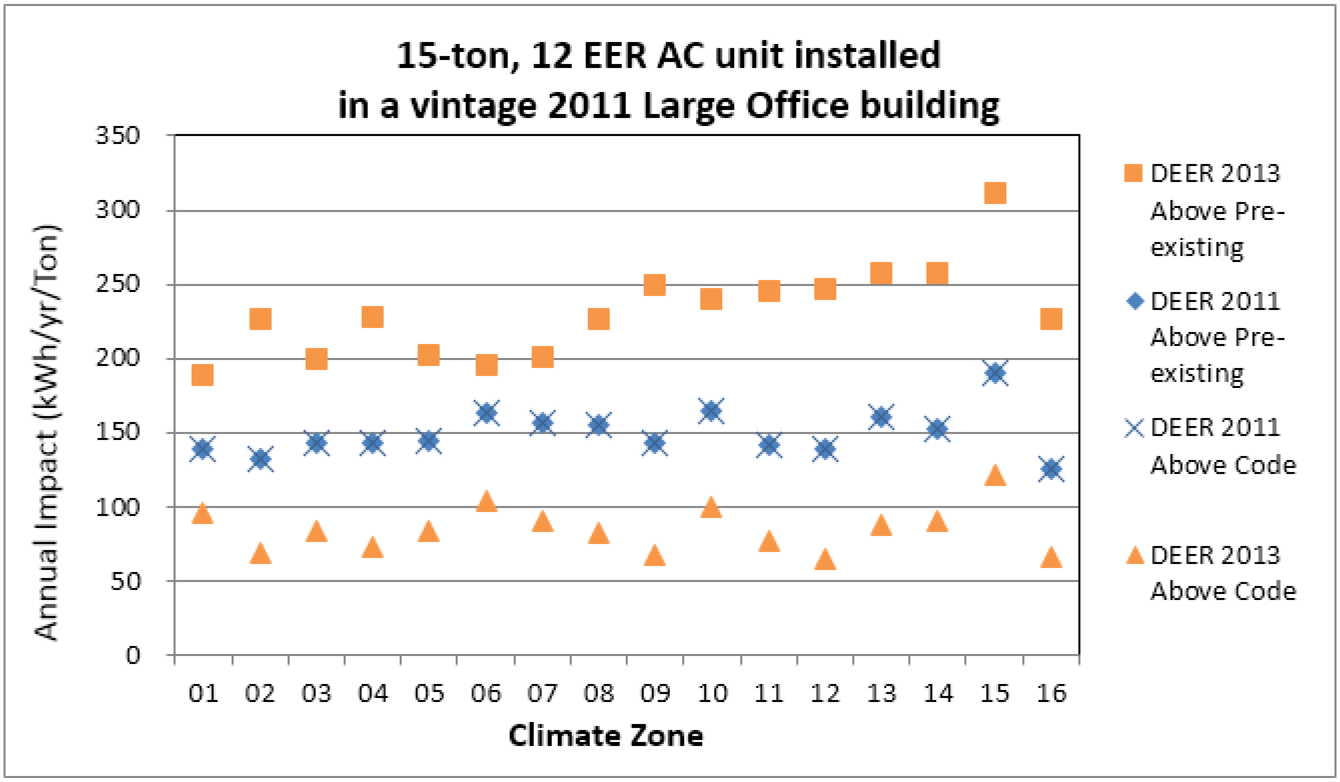

Figure 2.1.1. Comparison of annual kWh savings for a packaged AC measure in DEER2011 and DEER2013

To illustrate some of the issues regarding the code requirement for two-speed fans, figure 2.1.1 compares the above-code and above pre-existing energy savings for a 12-EER, 15-ton packaged AC measure installed in a vintage 2011 large office building.

- Compared to the DEER2011 impacts, the DEER2014 above-code savings ***decreases*** since both the measure and code technologies have 2-speed fans.
- Compared to the DEER2011 impacts, the DEER2014 above Pre-existing savings ***increases*** due to the measure technology having 2-speed fans and the pre-existing technology having single-speed fans.

- The DEER2011 impacts are the same for Above-Code and Above-PreExisting cases since the 2011 vintage building equipment matches the DEER2011 code requirement.
- The DEER2014 impacts are different for Above-Code and Above-PreExisting because the 2013 code requires 2-speed fans for this size unit, but the DEER2011 code did not require 2-speed fans.

2.2 Commercial Packaged Heat-pump equipment

The code level efficiency requirements for packaged heat pump equipment have been updated based on specifications in the 2013 Title-24. The code efficiency levels have dropped by 0.2 EER while the measure efficiency levels have not changed.

The table below shows the change in code level EER as well as the measure EER levels, which have not changed.

Size Range	Efficiency Parameter	Code Level 2008	Code Level 2013	Measure Level
65 - 89 kBTUh	EER	11.0	10.8	11.5
65 - 89 kBTUh	EER	11.0	10.8	12.0
90 - 134 kBTUh	EER	11.0	10.8	11.5
90 - 134 kBTUh	EER	11.0	10.8	12.0
135 - 239 kBTUh	EER	10.6	10.4	11.5
135 - 239 kBTUh	EER	10.6	10.4	12.0
240 - 759 kBTUh	EER	9.5	9.3	10.5
240 - 759 kBTUh	EER	9.5	9.3	10.8
> 760 kBTUh	EER	9.5	9.3	10.0
> 760 kBTUh	EER	9.5	9.3	10.2

Table 2.2.1. Efficiency levels for single-zone package heat pump equipment

Note 1: Heat pumps are assumed to all have electric resistance back up heat, however, code requirements require EER values that are 0.2 higher than those listed in Table 2.2.1 for heat pumps that do not use electric resistance heat. Heat pump results are scale-able based on the difference in COOLING-EIR (for cooling energy) and HEATING-EIR (for heating energy). Impacts for heat pumps without electric resistance heating can be developed within a workpaper and using scaled calculations based on the DEER results.

Above-code measure energy impacts have increased from about 20% to 30%, depending upon the measure efficiency and size range. The following figure shows the increase in savings of a 12-EER, 15-ton packaged HP installed in a small office building. Note that the annual energy impacts shown in this figure include the effects of the two-speed fan requirements discussed above.

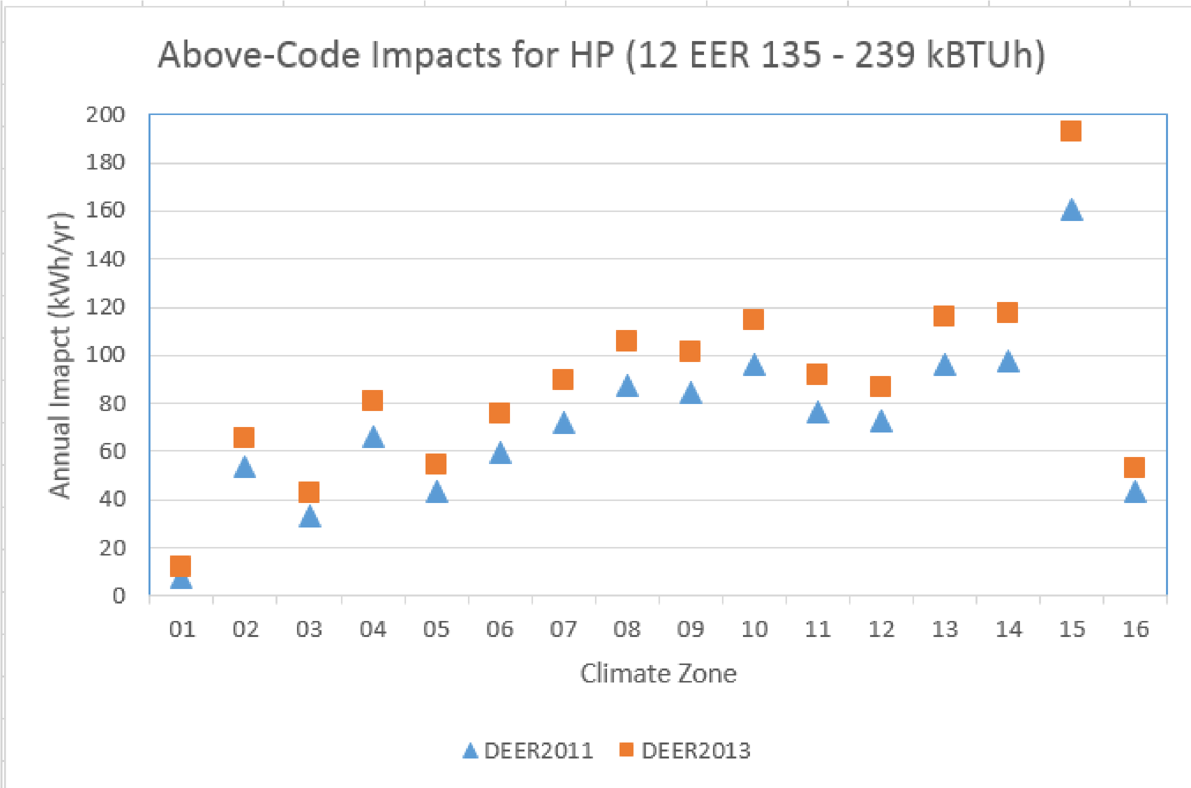

Figure 2.2.1. Comparison of above-code savings for a 12 EER 15-ton packaged HP in a Small Office Building

2.3 Chillers for Space Cooling

The 2013 Title-24 has new minimum efficiency levels as well as new size ranges for water-cooled chillers. The table below summarizes the changes from the 2008 Title-24 based DEER2011 measure specifications and the 2013 Title-24 based DEER2014 measure specifications.

	DEER2011				2013 Title-24 (Path A)		DEER2013			
Chiller type	Size (Tons)	Code kW/ton	Measure kW/ton	delta kw/ton	Size (Tons)	Code kW/ton	Size (Tons)	Code kW/ton	Measure kW/ton	delta kw/ton
Water-cooled reciprocating	all sizes	0.837	0.672	0.165	< 75	0.780	< 150	0.778	0.672	0.106
					>= 75, < 150	0.775				
					>= 150, < 300	0.680	>=150, <300	0.680	0.588	0.092
					>= 300	0.620	>= 300	0.620	0.536	0.084
Water-cooled rotary screw or scroll	< 150	0.790	0.632	0.158	< 75	0.780	< 150	0.778	0.632	0.146
					>= 75, < 150	0.775				
	>=150, <300	0.718	0.574	0.144	>= 150, < 300	0.680	>=150, <300	0.680	0.574	0.106
	>= 300	0.639	0.511	0.128	>= 300	0.620	>= 300	0.620	0.511	0.109
Water-cooled centrifugal	< 150	0.703	0.560	0.143	< 150	0.634	< 150	0.634	0.560	0.074
	>=150, <300	0.634	0.507	0.127	>= 150, < 300	0.507	>=150, <300	0.634	0.507	0.127
	>= 300	0.576	0.461	0.115	>= 300, < 600	0.576	>= 300	0.573	0.461	0.112
					>= 600	0.570				

Table 2.3.1. Title-24 and DEER specifications for water-cooled Chillers

As has been done in previous cycles, IOU workpapers can utilize the results for these measures to create measure energy impacts that are based on alternative measure efficiency levels. To do this, the energy impacts for the appropriate water-cooled chiller category are divided by the DEERΔkW/ton (code efficiency level minus the measure efficiency level) and multiplied by the IOU measure definitionΔkW/ton. Chiller energy impacts are for replace-on-burnout applications with only above-code energy impacts relevant to the measure savings.

Alternatively, ED can create energy impacts and measure definitions that are scaled based on the delta kW/ton. However, based on current IOU portfolio submissions, there are no deemed water-cooled chiller measures being offered.

The 2013 Title-24 requirements for air-cooled chillers have not changed and the DEER2014 specifications, shown in the following table, have not changed from the previous DEER version.

Title-24 2008			DEER2011	Title-24 2013 (Path A)				DEER2013			
Size	COP	kw/ton	Measure kw/ton	Size (Tons)	Path A EER	kW/ton	COP	Size (Tons)	Code kW/Ton	Measure kw/ton	delta kw/ton
< 150 tons	2.80	1.26	1.008	< 150	9.562	1.26	2.80	< 150	1.256	1.008	0.248
>= 150 tons	2.80	1.26	1.008	>= 150	9.562	1.26	2.80	>= 150	1.256	1.008	0.248

Table 2.3.2. Title-24 and DEER specifications for Air-cooled Chillers with condenser

Note 1 to Tables 2.3.1 and 2.3.2: Title 24 includes two paths (A and B) for determining the minimum efficiency requirements for chillers. Each path includes a steady state efficiency requirement in kW/ton, determined a single set of operating conditions, and an annualized average requirement in Integrated Part Load Value (IPLV). The IPLV is calculated by weighting together the steady state efficiencies at several sets of operating conditions. Path A is generally intended to apply to chillers that operate a large portion of the time at or near full load conditions, whereas Path B is for chillers are likely to operate at part load. Path A has a more stringent kW/ton than Path B. DEER savings values are based on Path A efficiency requirements. Chiller energy savings in DEER are based on the steady state efficiency (kW/ton), not on the IPLV, and impacts can be scaled based on the difference in steady state efficiency. Impacts for chillers meeting Path B efficiency requirements can be developed within a workpaper and using scaled calculations based on the DEER results.

2.4 Hot water and Steam Boilers for Space Heating

The 2013 Title-24 raises efficiency levels for large hot-water and steam boilers for space heating across the full range of boiler types and sizes. The AFUE of boilers rated at less than 300 kBTUh are specified based on the EISA 2007 code levels, which increased as of 9/1/2012. The following table shows the increase in the code-compliant efficiency level and the DEER measure efficiency level. The DEER measure efficiency levels have not changed.

Boiler Type	Size Range	Efficiency Parameter	Combustion Type	DEER2011 Code Efficiency	DEER2013 Code Efficiency	DEER2013 Measure Efficiency	Approx. Decrease in Energy Impact
Hot Water	<300 kBTUh	AFUE	Atmospheric	80	82	84	50%
		AFUE	Draft	80	82	84	50%
		AFUE	Condensing	80	82	94	14%
	300 - 2500 kBTUh	Thermal Efficiency	Atmospheric	75	80	85	50%
		Thermal Efficiency	Draft	75	80	85	50%
		Thermal Efficiency	Condensing	75	80	94	26%
	> 2500 kBTUh	Combustion Efficiency	Atmospheric	75	82	85	70%
		Combustion Efficiency	Draft	75	82	85	70%
Steam	<300 kBTUh	AFUE	Atmospheric	75	80	82	71%
		AFUE	Draft	75	80	82	71%
	300 - 2500 kBTUh	Thermal Efficiency	Atmospheric	75	77	85	20%
		Thermal Efficiency	Draft	75	79	85	40%
	> 2500 kBTUh	Combustion Efficiency	Atmospheric	75	77	80	40%
		Combustion Efficiency	Draft	75	79	80	80%
DEER2011 code efficiency level based on EISA 2007							
DEER2013 code efficiency level based on 2013 Title-24 and EISA 2007 for <300 kBTUh boilers							

Table 2.4.1. Hot Water and Steam Boiler efficiency specifications

2.5 Electric Small Storage and Instantaneous Water Heaters

The code-level Energy Factor (EF) for small electric and instantaneous water heaters was incorrectly specified in DEER2011. The EF for electric storage water heaters is specified under the EISA 2007 code as:

$$EF = 0.97 - (0.00132 \times RatedVolumeGallons)$$

For electric instantaneous water heaters, the equation is:

EF = 0.93 - (0.00132 x RatedVolumeGallons)

DHW Type	Size	DEER2011 Code EF	DEER2013 Code EF	DEER2013 Msr EF	Approx. Decrease in Energy Impact
Electric Instantaneous	<2 gallons	0.88	0.93	0.98	50%
Electric storage	30 gallons	0.89	0.93	0.95	66%
	40 gallons	0.88	0.92	0.94	68%
	50 gallons	0.86	0.90	0.93	55%
	60 gallons	0.85	0.89	0.92	57%
	75 gallons	0.83	0.87	0.91	49%

Table 2.5.1. Comparison of electric water heater Efficiency Factors

The code level efficiency values are from EISA 2007, which supersedes the efficiency requirements in the California Title-20 specifications.

2.6 Changes from the DEER2011 Processing of Energy Impact results

The weighting of energy impacts for three HVAC measures has been updated. Prior to this update, these measures incorrectly weighted the "zero impact" records for recent vintages (2014, 2011 and 2007 vintages) into the "existing" vintage energy impacts. The process was updated by removing the energy impact records for the vintages that had no energy savings. The updated existing vintage energy impacts are approximately 10% higher than the previous results for the following commercial HVAC measures:

- NE-HVAC-airAC-Pkg-lt55kBtuh-13p0seer
- NE-HVAC-airAC-Split-lt55kBtuh-13p0seer
- NE-HVAC-airHP-Split-lt55kBtuh-13p0seer-7p7hspf

3.0 Updated Appliance Measures

3.1 Residential Dishwashers

New code requirements for residential dishwashers were phased-in on 5/30/2013 under EISA 2007. The new metric for energy efficiency is the EAEU, or estimated annual energy use. This rating value encompasses both the dishwasher machine energy (direct kWh consumption) and the energy required for the dishwasher hot water use.

The current code standards require that the DEER2011 dishwasher measures be redefined using the new EAEU metric and new measure efficiency levels. Two efficiency levels were derived based on the units listed by CEE in the Qualifying Residential Dishwashers spreadsheet dated May 17, 2013.

Proposed Residential Dishwasher Specifications									
Building Type	Measure Description	EAEU	EF	cycles/yr	Standby Watts	Gallons per cycle	Machine kWh/cycle	Gallons per year	Machine kWh/yr
Single Family	Code Level	307	0.72	153	1	6.5	0.52	995	88
Single Family	High Efficiency	260	0.86	153	1	3.25	0.62	497	104
Single Family	Very High Efficiency	180	1.26	153	1	2.22	0.42	340	74
Multifamily	Code Level	307	0.72	111	1	6.5	0.52	722	66
Multifamily	High Efficiency	260	0.86	111	1	3.25	0.62	361	78
Multifamily	Very High Efficiency	180	1.26	111	1	2.22	0.42	246	56
rated Energy Factor (EF) = 1 / (machine kWh per cycle + gallons per cycle * 0.168)									

Table 3.1.1. Proposed dishwasher specifications based on EISA 2007 code requirements

ED can modify or augment the dishwasher measure definitions to include alternate efficiency levels, based on IOU program offerings.

As with DEER2011, there are two versions of each dishwasher measure: one for households with gas water heating and one with households with electric water heating. These measure results are weighted together based on DHW fuel weights for each IOU to create a non-fuel specific dishwasher measure. The same weights are used as documented in DEER2011.

3.2 Residential Refrigerators

The next phase-in date for residential refrigerator efficiency improvements is 9/15/2014. The reference energy impacts for residential refrigerators are updated in DEER2014 and can be used to develop technology-specific measures and energy impacts for updated IOU program offerings.

4.0 Commercial Lighting Systems

In general, the few changes in lighting system requirements in the 2013 Title-24 have not affected the methodology by which code lighting technologies are assigned to measure lighting technologies.

DEER2011 lighting measures that utilized first-generation T-8 lamps for the code base have been replaced with second-generation equivalent lamps. Since the second-generation code base measures were already included in DEER2011 as “major retrofit” measures, the first-generation code base measures were essentially dropped from the measure list.

4.1 Occupancy Sensors

The code requirement for occupancy sensors in select activity areas for lighting upgrades has been incorporated into the commercial CFL and non-CFL (linear fluorescent and high-bay) lighting measures. In the DEER2014 database, each of these lighting measures has three sets of energy impacts, corresponding to three occupancy sensor scenarios:

1 Building-wide Average Occupancy Sensors
   - Occupancy sensors are applied to only the spaces within the DEER building types where Title-24 would likely require them.
   - Occupancy sensors are applied to the pre-existing case for building vintages after 2009 and to the code/standard and measure cases for all building vintages.
   - This scenario is used when the occupancy sensors are not specifically required as part of a measure installation and pre-existing fixtures are not controlled by occupancy sensors.
   - This is the default scenario for deemed measures when no information is known about existing or required occupancy sensors.

2 Occupancy Sensors in all appropriate spaces
   - Occupancy sensors are included in all spaces of the building where appropriate.
   - Occupancy sensors are assumed in the lighting system for all cases (pre-existing, code/standard and measure cases).
   - This scenario is used when the lighting measure's pre-existing fixtures are known to be controlled by occupancy sensors.

3 No Occupancy Sensors
   - No occupancy sensors assumed in the lighting system for all cases (pre-existing, code/standard and measure cases).
   - This scenario is used by custom measures in situations where occupancy sensors are known to not be required or used.

The READI tool allows the occupancy sensor scenario to be chosen by way of the measure definition’s “Impacts Qualifier”. The “Impacts Qualifier” is presented as a pull-down menu within the measure definition. The default qualifier, if no choice is made, is option 1 above.

Calculation of Energy Savings for Lighting Measures with Occupancy Sensors

When the same level of occupancy sensors are present in the pre-existing case as well as the code/standard and measure cases (as in scenario 2 above), the associated energy impacts are reduced by the ratio of HOU_{os}/HOU_{nos} compared to the measure with no occupancy sensors. In this scenario, if the hours-of-use decrease by 10% due to occupancy sensors, the lighting energy impacts decrease by 10% compared to the measure that assumes no occupancy sensors.

For the case where the HOU decreases from the pre-existing case to the measure case (as in scenario 1 above), there are two components of the energy savings: the savings realized by the reduction in HOU and savings realized by the reduction in the lighting technology kW.

Above Pre-Existing, Direct Energy Savings (RUL period) =

$$Ltg\_kW_{pre} * (HOU_{nos} - HOU_{os}) + (Ltg\_kW_{pre} - Ltg\_kW_{msr}) * HOU_{os}$$

Above Pre-Existing, Whole-Building Energy Savings (RUL period) =

Direct Energy Savings * Interactive Effect factor for energy =

$$(Ltg\_kW_{pre} * (HOU_{nos} - HOU_{os}) + (Ltg\_kW_{pre} - Ltg\_kW_{msr}) * HOU_{os}) * IE_{kWh}$$

Above Pre-Existing, Direct Electric Demand Savings (RUL period) =
$Ltg\_kW_{pre} * (CDF_{nos} - CDF_{os}) + (Ltg\_kW_{pre} - Ltg\_kW_{msr}) * CDF_{os}$

Above Pre-Existing, Whole-Building Electric Demand Savings (RUL period) =
Direct Energy Savings * Interactive Effect factor for demand =
$(Ltg\_kW_{pre} * (CDF_{nos} - CDF_{os}) + (Ltg\_kW_{pre} - Ltg\_kW_{msr}) * CDF_{os}) * IE_{kW}$

Above Pre-Existing, Direct Gas take-back (RUL period) is zero, and

Above Pre-Existing, Whole Building Gas take-back (RUL period) =
Lighting Direct kWh Savings * Interactive Effect factor for gas take-back =
$(Ltg\_kW_{pre} * (HOU_{nos} - HOU_{os}) + (Ltg\_kW_{pre} - Ltg\_kW_{msr}) * HOU_{os}) * IE_{therm}$

The same formulas apply to the Above Code/Standard savings calculations, but in this case $HOU_{nos} = HOU_{os}$ and $CDF_{nos} = CDF_{os}$, and therefore the equations simply to:

Above Code/Standard, Direct Energy Savings =
$(Ltg\_kW_{std} - Ltg\_kW_{msr}) * HOU_{os}$

Above Code/Standard, Whole-Building Energy Savings =
Direct Energy Savings * Interactive Effect factor for energy =
$(Ltg\_kW_{std} - Ltg\_kW_{msr}) * HOU_{os} * IE_{kWh}$

Above Code/Standard, Direct Electric Demand Savings =
$(Ltg\_kW_{std} - Ltg\_kW_{msr}) * CDF_{os}$

Above Code/Standard, Whole-Building Electric Demand Savings =
Direct Energy Savings * Interactive Effect factor for demand =
$(Ltg\_kW_{std} - Ltg\_kW_{msr}) * CDF_{os} * IE_{kW}$

Above Code/Standard, Direct Gas take-back is zero, and

Above Code/Standard, Whole Building Gas take-back (RUL period) =
Lighting Direct kWh Savings * Interactive Effect factor for gas take-back =
$(Ltg\_kW_{std} - Ltg\_kW_{msr}) * HOU_{os} * IE_{therm}$

Where:

HOU_{os}	= Hours-of-Use with Occupancy sensors
HOU_{nos}	= Hours-of-Use with No Occupancy sensors
CDF_{os}	= Coincident Demand Factor with Occupancy sensors
CDF_{nos}	= Coincident Demand Factor with No Occupancy sensors
Ltg_kW_{pre}	= Pre-existing Lighting technology direct kW
Ltg_kW_{std}	= Code/Standard Lighting technology direct kW
Ltg_kW_{msr}	= Measure Lighting technology direct kW
IE_{kWh}	= Lighting HVAC interactive effect (kWh/kWh)
IE_{kW}	= Lighting HVAC interactive effect (kW/kW)
IE_{therm}	= Lighting HVAC interactive effect (therm/kWh)

For some building types, such as retail and restaurant, there is no change in savings because occupancy sensors are not required in the building's activity areas. In other building types, such as offices, the savings change by as much as 15%. For details on how the occupancy sensors where applied to the various building types and how the HOU and CDF adjustment factors were derived, see the accompanying workbook ("DEER_EFLH+CDF+OccSensor_October2013-v4.xlsx" in the DEER2014 directory of the DEEResources.com ftp site).

The HOU and CDF values used in the equations above are summarized in the following two tables.

	Building-wide average Occupancy Sensors (default scenario)							
	Non-CFL Lighting				CFL Lighting			
Building	New Vintage		Existing Vintage		New Vintage		Existing Vintage	
Code	HOU	CDF	HOU	CDF	HOU	CDF	HOU	CDF
Asm	0.975	0.980	0.971	0.976	0.983	0.982	0.980	0.979
EPr	0.910	0.902	0.911	0.894	0.943	0.903	0.943	0.895
ESe	0.924	0.920	0.925	0.913	0.948	0.920	0.948	0.913
ECC	0.937	0.885	0.938	0.889	0.954	0.894	0.955	0.898
EUn	0.934	0.884	0.935	0.889	0.955	0.879	0.956	0.883
ERC	0.882	0.867	0.882	0.856	0.919	0.867	0.919	0.856
Gro	0.989	0.989	0.989	0.989	0.991	0.989	0.991	0.989
Hsp	0.996	0.995	0.996	0.994	0.996	0.994	0.996	0.994
Nrs	0.984	0.984	0.983	0.982	0.987	0.984	0.986	0.982
Htl	0.979	0.978	0.981	0.980	0.982	0.980	0.984	0.982
Mtl	0.968	0.966	0.968	0.965	0.973	0.968	0.973	0.968
MBT	0.969	0.981	0.970	0.980	0.983	0.981	0.984	0.981
MLI	0.999	0.998	0.999	0.998	0.999	0.998	0.999	0.998
OfL	0.942	0.947	0.944	0.948	0.961	0.947	0.962	0.948
OfS	0.868	0.877	0.867	0.876	0.915	0.877	0.914	0.876
RSD	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
RFF	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Rt3	0.998	0.997	0.998	0.998	0.999	0.997	0.999	0.997
RtL	0.999	0.998	0.999	0.998	0.999	0.998	0.999	0.998
RtS	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
SCn	0.990	0.981	0.990	0.981	0.993	0.981	0.993	0.981
SUn	0.990	0.981	0.990	0.981	0.993	0.981	0.993	0.981
WRf	0.954	0.979	0.953	0.978	0.986	0.979	0.985	0.978

Table 4.1.1. Occupancy Sensor Hours-of-Use and Coincident Demand Factor Multipliers for "Default_Bldg_OS" scenario

	Occupancy Sensors in All Spaces							
	Non-CFL Lighting				CFL Lighting			
Building	New Vintage		Existing Vintage		New Vintage		Existing Vintage	
Code	HOU	CDF	HOU	CDF	HOU	CDF	HOU	CDF
Asm	0.853	0.810	0.851	0.812	0.885	0.809	0.883	0.811
EPr	0.871	0.874	0.871	0.863	0.914	0.874	0.914	0.864
ESe	0.873	0.878	0.873	0.867	0.911	0.878	0.911	0.867
ECC	0.882	0.819	0.880	0.820	0.917	0.822	0.917	0.823
EUn	0.879	0.822	0.878	0.823	0.918	0.821	0.916	0.822
ERC	0.882	0.867	0.882	0.856	0.919	0.867	0.919	0.856
Gro	0.970	0.965	0.972	0.968	0.977	0.965	0.978	0.968
Hsp	0.926	0.917	0.927	0.918	0.933	0.914	0.934	0.916
Nrs	0.868	0.861	0.866	0.859	0.890	0.859	0.889	0.857
Htl	0.846	0.856	0.836	0.854	0.884	0.860	0.880	0.858
Mtl	0.868	0.862	0.868	0.862	0.891	0.865	0.891	0.865
MBT	0.855	0.855	0.858	0.854	0.901	0.855	0.899	0.855
MLI	0.880	0.849	0.879	0.849	0.889	0.849	0.888	0.849
OfL	0.798	0.810	0.798	0.811	0.862	0.810	0.863	0.811
OfS	0.725	0.743	0.723	0.741	0.822	0.743	0.821	0.741
RSD	0.802	0.848	0.802	0.848	0.897	0.847	0.897	0.847
RFF	0.831	0.850	0.831	0.850	0.897	0.850	0.897	0.850
Rt3	0.990	0.985	0.990	0.986	0.994	0.983	0.994	0.985
RtL	0.990	0.989	0.992	0.990	0.993	0.987	0.994	0.988
RtS	0.983	0.983	0.986	0.986	0.986	0.983	0.989	0.986
SCn	0.917	0.840	0.917	0.840	0.942	0.840	0.942	0.840
SUn	0.917	0.840	0.917	0.840	0.942	0.840	0.942	0.840
WRf	0.656	0.850	0.657	0.850	0.897	0.850	0.897	0.850

Table 4.1.2. Occupancy Sensor Hours-of-Use and Coincident Demand Factor Multipliers for "All-Spaces-OS" scenario

4.2 Lighting Technologies

For DEER2014, additional lighting technologies were added to the DEER technology tables based on lighting technologies referenced in IOU workpapers and in IOU tools. The DEER list of code lighting technologies that are associated with measure lighting technologies is expanded to include as many of the new technology additions as possible.

DEER2014 Lighting Technologies Technology Group	 Technology Type	Number of techs
Lighting - Lamps	Incandescent Lamp	54
Lighting - Lamps	Integral CFL (screw-in)	120
Lighting - Lamps	Pin-based CFL (no ballast)	97
Lighting - Lamps	Halogen Lamp	46
Lighting - Lamps	LED Lamp	124
Lighting - Lamps	Linear Fluorescent Lamp	60
Lighting - Ballasts	Fluorescent Ballast	213
Lighting - Lamps + Ballasts	Linear Fluorescent Lamp with Ballast	659
Lighting - Lamps + Ballasts	HID Lamp with Ballast	71
Lighting - Lamps + Ballasts	Component-based CFL Lamp and Ballast	12
Lighting - Lamps + Ballasts	Induction Lamp with Ballast	25
Lighting - Fixtures	Linear Fluorescent Fixture	33
Lighting - Fixtures	Exit Fixture	29
Lighting - Fixtures	LED Fixture	875
Lighting - Fixtures	HID Fixture	18
Lighting - Fixtures	CFL Fixture	221
Lighting - Fixtures	Induction Fixture	47
Lighting - Plug-in	Light String	2
Lighting - Plug-in	Night Light	8
Lighting - Plug-in	Fixture	4
Lighting - Plug-in	Signage	4

Table 4.2.1. Current Lighting technologies in the DEER database

4.3 Residential CFL Effective Useful Life update

The degradation factor in the DEER2014 EUL table for Residential CFLs (EUL ID = “ILtg-CFL-Res”) is updated to 0.523, as originally documented for the DEER2008 release. In DEER2011, the value for the degradation factor was truncated to 0.5. Also, EUL records for CFL lamps with rated life of 6,000, 8,000 and 12,000 hours have been added to the DEER2014 EUL table.

5.0 Title-24 Improvements not related to Measure Definitions

There are number of code changes implemented for the DEER2014 prototypes that are unrelated to specific measures. These changes, such as improved window specifications, affect overall building heating and cooling energy use. Since the new code requirements are aimed at improving a building’s energy performance, the energy impacts for measures that are dependent on the building’s heating and cooling energy use can be expected to decrease due to the improved overall energy efficiency of the building.

The table below summarizes the categories of changes that are not part of any DEER measures.

Building Component	Description	T24 - 2008	T24 - 2013
Motor Efficiency	Change from NEMA high efficiency to premium efficiency motors for air handler fans, chilled water pumps, condenser water pumps and heating water	NEMA High Efficiency	NEMA Premium
Economizer	Minor changes to high limit shut-off control requirements for some climate zones	70 to 75 F	69 to 75 F
Non-residential Windows	Change from dependency on window/wall ratio to type of window: fixed, operable curtainwall/storefront	U 0.47 to 0.77 SHGC 0.31 to 0.72	U: 0.36 to 0.41 SHGC: 0.22 to
Residential Windows	Independent of climate zone, except no SHGC requirement for some regions	U: 0.4 SHGC: 0.4	U: 0.32 and SHGC: 0.25
Residential Exterior Walls	Change from climate dependent requirement for cavity insulation to single requirement of cavity insulation plus	R13 to R21 Cavity based on climate zone	R15 cavity plus R4 continuous (or equivalent)

Table 5.0.1. Summary of miscellaneous Title-24 changes

The “New” vintage of building types in DEER2014 have been updated to include these recent code changes and a new vintage (“2014 - 2015”) has been added that represents existing buildings built to the 2013 Title-24 standards.

Additional details can be found in the workbook SummaryOfCodeChanges.xlsx on the DEEResources.com FTP site under “DEER2014”.

6.0 New Weather Files for energy simulations

For the first time since 1992, Title-24 has adopted a new set of new weather files for energy simulations. Statewide typical months were chosen from weather data obtained from 1997 through 2008. This methodology varies from the development of the previous set of weather files by using the same selection for a typical month for all locations, as opposed to selecting typical months for each individual site. This new method provides better synchronization of the weather data across all of the climate zones, but also leads to some significant differences between the previous weather data for some locations.

6.1 Comparison of the CTZ2 and CZ2010 weather data files

While the recent update to the weather files re-evaluated the weather data of the entire state, the basic structure of the weather files for use in Title-24 compliant energy simulations has remained the same. There are still 16 weather files representing the same geographic areas as the previous versions. Half of the reference locations have changed and a few of the reference site elevations have changed significantly, as shown in the table below.

Climate Zone	2008 Title-24 (DEER2011)		2013 Title-24 (DEER2014)	
	location	elevation (ft)	location	elevation (ft)
CTZ01	Arcata	43	Arcata	203
CTZ02	Santa Rosa	164	Santa Rosa	125
CTZ03	Oakland	6	Oakland	6
CTZ04	Sunnyvale	97	San Jose-Reid	135
CTZ05	Santa Maria	236	Santa Maria	253
CTZ06	Los Angeles	97	Torrance	88
CTZ07	San Diego	13	San Diego-Lindbergh	13
CTZ08	El Toro	383	Fullerton	395
CTZ09	Pasadena	655	Burbank-Glendale	741
CTZ10	Riverside	1543	Riverside	**840**
CTZ11	Red Bluff	342	Red Bluff	348
CTZ12	Sacramento	17	Sacramento	16
CTZ13	Fresno	328	Fresno	335
CTZ14	China Lake	2293	Palmdale	2523
CTZ15	El Centro	-30	Palm Springs-Intl	**475**
CTZ16	Mount Shasta	3544	Blue Canyon	**5279**

Table 6.1.1. Reference locations for the CEC climate zones

While nearly all of the fields in the weather files impact building energy use to some degree, the data types that impact cooling and heating energy the most are the drybulb temperature, the humidity ratio (or another metric of moisture in the air) and solar radiation. Each of these are examined in some detail below to provide a basis to understand how and why cooling and heating energy use in a building may differ due to the new weather files.

A detailed comparison of the new and previous weather data can be made by using an Excel workbook created for this task. The workbook is located on the DEEResources.com FTP site under “DEER2014”.

Drybulb Temperature

The figure below compares the annual average and maximum drybulb temperatures for all 16 climate zones. The annual average temperatures for the two data sets only deviate by a couple degrees for a few of the locations while the annual maximum temperature can differ by as much as 12 degrees F and differs by at least 5 degrees for half of the locations.

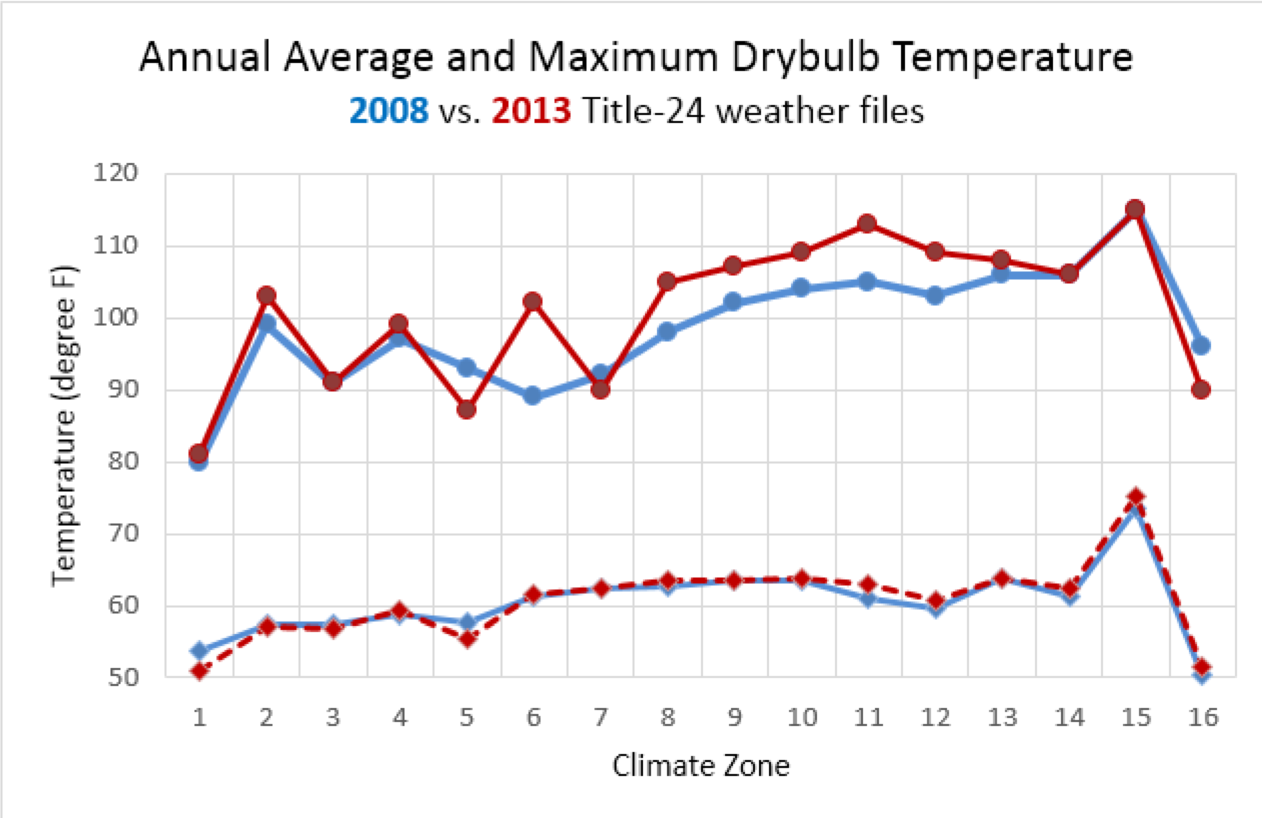

Figure 6.1.1. Comparison of Annual Average and Maximum drybulb temperatures

A better metric for indicating how changes in the temperature data may impact heating and cooling loads in buildings are the heating and cooling degree-hours. These values are calculated as the annual sum of the deviation of the drybulb temperature above (for cooling) or below (for heating) a reference temperature.

The table below compares the cooling and heating degree-hours (based on 65 degree F) for the new set of weather files and the previous (CTZ2) set of weather files. The color-coded right column indicates if the new data for a specific climate zone is significantly hotter or cooler than the previous weather data.

Climate Zone	Cooling DegHrs$_{65}$/24 2011	Cooling DegHrs$_{65}$/24 2014	ratio New/Prev	Heating DegHrs$_{65}$/24 2011	Heating DegHrs$_{65}$/24 2014	ratio New/Prev
CZ01	57	13	0.22	4207	5094	1.21
CZ02	1003	918	0.92	3809	3835	1.01
CZ03	354	250	0.71	3107	3257	1.05
CZ04	861	949	1.10	3090	3050	0.99
CZ05	493	262	0.53	3162	3715	1.17
CZ06	615	725	1.18	1962	2013	1.03
CZ07	774	471	0.61	1735	1478	0.85
CZ08	1142	1131	0.99	1972	1702	0.86
CZ09	1466	1462	1.00	2004	2000	1.00
CZ10	1829	1827	1.00	2361	2240	0.95
CZ11	1729	2286	1.32	3245	3027	0.93
CZ12	1331	1528	1.15	3351	3122	0.93
CZ13	2252	2375	1.05	2677	2794	1.04
CZ14	2147	2384	1.11	3486	3322	0.95
CZ15	4413	4829	1.09	1348	1102	0.82
CZ16	720	651	0.90	6059	5578	0.92

Table 6.1.1. Comparison of Cooling and Heating degree-days

CZ01 continues to be one of the coolest locations in mainland US, but it was essentially a heating-only climate in the previous weather set as well. Climate zones CZ03, CZ05 and CZ07 are significantly cooler based on the cooling degree-days of the newer weather files. Of these three sites, CZ07 (San Diego) has the most substantial reduction in potential cooling load, with a reduction of about 300 degree-days (base 65F), or about 40% of the cooling degree-days.

A number of sites have higher potential cooling load, with the cooling degree-days in CZ11 (Red Bluff) increasing the most. Similar trends are seen when examining the heating degree-days for these sites. Climate zone CZ07 is interesting in that the new weather data has fewer degree-days for both cooling and heating while maintaining almost the exact same average annual temperature. Examination of hourly data, as in the two figures below, shows that the updated weather data for San Diego, well known for its mild climate, has significantly less daily variation compared with the previous weather data.

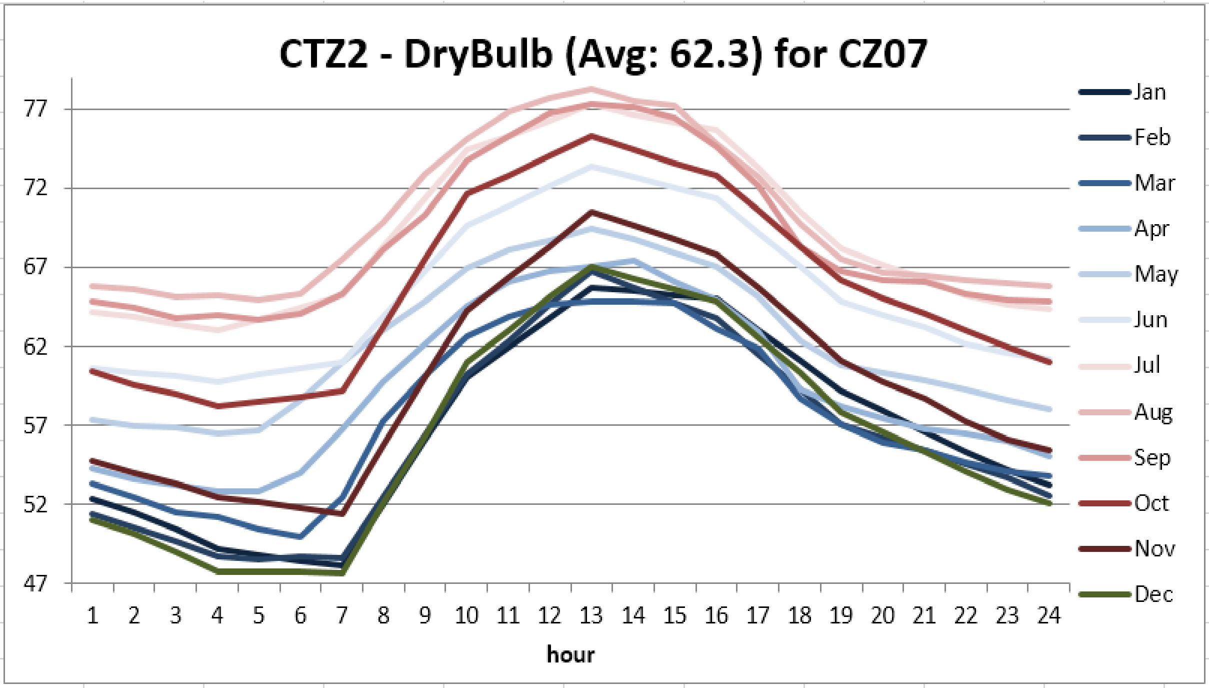

Figure 6.1.2. Monthly temperature profiles for CZ07 based on previous weather data

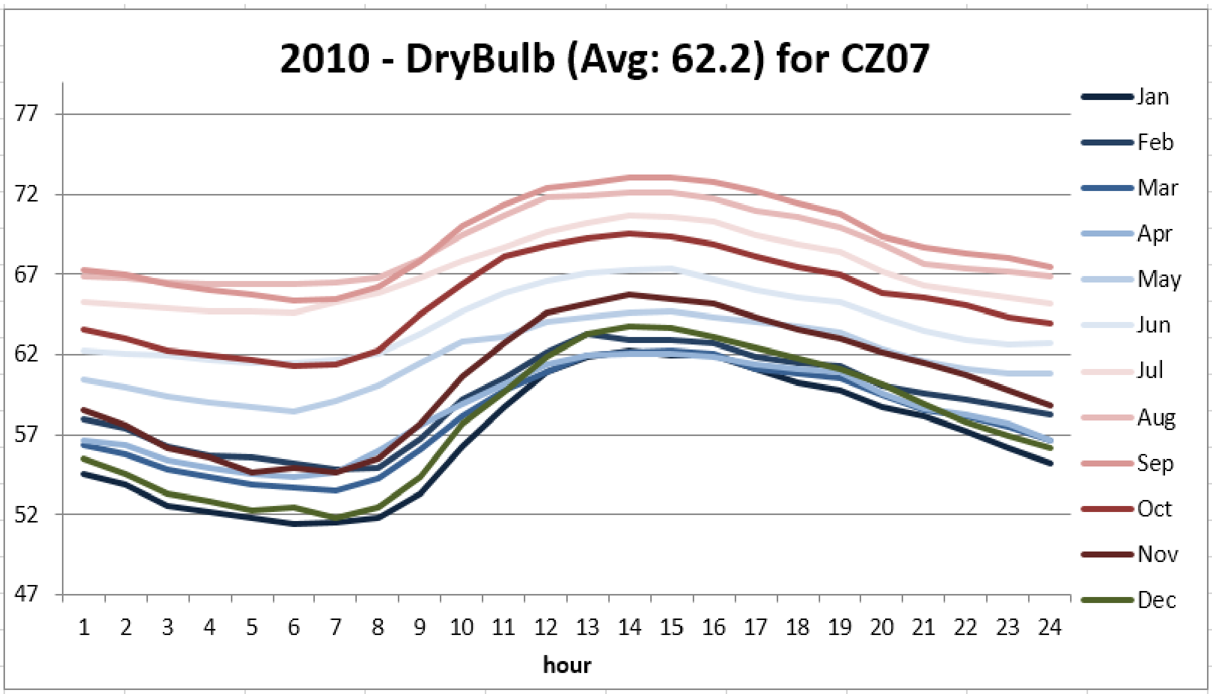

Figure 6.1.3. Monthly temperature profiles for CZ07 based on new weather data

Humidity Ratio

The amount of moisture in the air can have a large impact on cooling loads, especially in building types that require a large amount of outdoor air for ventilation, such as classrooms and hospitals. The table below compares the annual average humidity ratio (pounds of water vapor per pound of dry air) in the two weather file sets for all climate zones.

Climate Zone	Humidity Ratio		ratio New/Prev
	2011	2014	
CZ01	0.0076	0.0069	0.91
CZ02	0.0064	0.0068	1.06
CZ03	0.0076	0.0073	0.97
CZ04	0.0078	0.0072	0.92
CZ05	0.0076	0.0071	0.93
CZ06	0.0083	0.0087	1.04
CZ07	0.0084	0.0089	1.06
CZ08	0.0082	0.0083	1.01
CZ09	0.0077	0.0079	1.02
CZ10	0.0070	0.0075	1.07
CZ11	0.0055	0.0064	1.16
CZ12	0.0067	0.0070	1.05
CZ13	0.0069	0.0070	1.02
CZ14	0.0033	0.0055	1.67
CZ15	0.0050	0.0066	1.31
CZ16	0.0053	0.0046	0.88

Table 6.1.2. Comparison of Humidity Ratio

The two climate zones with the lowest humidity ratio in the previous weather files (CZ14, CZ15) have the greatest increase while the cooler climate zones have moderate decreases in moisture content.

Solar Radiation Comparison

The heating and cooling requirement in buildings with large amounts of fenestration or large fractions of roof area can be highly dependent on the amount of solar radiation striking those surfaces. The table below compares the amount of total solar radiation incident on a horizontal surface and the direct normal solar radiation (in BTU/hr-ft^2) between the two weather file sets.

Climate Zone	Horizontal		ratio	Direct Normal		ratio
	2011	2014	New/Prev	2011	2014	New/Prev
CZ01	50.3	52.7	1.05	43.2	51.0	1.18
CZ02	62.7	65.2	1.04	69.6	71.1	1.02
CZ03	63.4	64.0	1.01	70.3	65.0	0.92
CZ04	66.0	67.0	1.01	74.3	74.4	1.00
CZ05	66.6	68.5	1.03	73.9	76.6	1.04
CZ06	67.2	65.8	0.98	73.9	63.4	0.86
CZ07	66.4	67.8	1.02	69.8	72.1	1.03
CZ08	68.3	67.3	0.99	75.7	67.3	0.89
CZ09	66.2	69.2	1.05	73.4	75.5	1.03
CZ10	68.0	69.6	1.02	75.4	75.2	1.00
CZ11	66.0	65.9	1.00	81.5	79.8	0.98
CZ12	68.8	65.9	0.96	84.0	72.6	0.86
CZ13	72.0	66.8	0.93	86.5	72.9	0.84
CZ14	75.9	75.3	0.99	96.6	96.3	1.00
CZ15	74.3	73.0	0.98	87.3	88.7	1.02
CZ16	62.8	68.3	1.09	71.8	88.0	1.22

Table 6.1.3. Comparison of Horizontal and Direct Normal Solar Radiation (BTU/hr-ft^2)

The two coldest climate zones (CZ01 and CZ16) both have a significant increase in solar radiation, especially the direct normal (beam) radiation.

6.2 DEER Peak Period Definitions

To determine the electric demand impacts of measures, DEER uses the average kWh reduction over a 9-hour window. The nine-hour window is from 2p.m. to 5 p.m. over a three-day “heat wave” that is determined for each climate zone. The peak periods for use with DEER demand impact calculations were determined based on the new weather file data and are shown below, along with the previous peak demand period definitions.

Climate Zone	CZ2 (2008 Title-24) Weather Files Start Date		Weekday	Peak T	Ave T	CZ2010 (2013 Title-24) Weather Files Start Date		Weekday	Peak T	Ave T
CZ01	Sep	30	Mon	80	58.0	Sep	16	Wed	81	59.8
CZ02	Jul	22	Mon	99	77.9	Jul	8	Wed	103	75.9
CZ03	Jul	17	Wed	89	65.4	Jul	8	Wed	91	69.2
CZ04	Jul	17	Wed	97	70.8	Sep	1	Tue	99	77.5
CZ05	Sep	3	Tue	93	67.6	Sep	8	Tue	87	64.8
CZ06	Jul	9	Tue	85	69.0	Sep	1	Tue	102	77.1
CZ07	Sep	9	Mon	92	70.1	Sep	1	Tue	90	73.9
CZ08	Sep	23	Mon	98	78.2	Sep	1	Tue	105	79.8
CZ09	Aug	6	Tue	101	78.3	Sep	1	Tue	107	86.6
CZ10	Jul	8	Mon	104	83.5	Sep	1	Tue	109	86.3
CZ11	Jul	31	Wed	104	80.7	Jul	8	Wed	113	88.3
CZ12	Aug	5	Mon	103	81.0	Jul	8	Wed	109	82.4
CZ13	Aug	14	Wed	106	87.1	Jul	8	Wed	108	86.7
CZ14	Jul	9	Tue	106	89.7	Aug	26	Wed	105	86.8
CZ15	Jul	30	Tue	114	96.2	Aug	25	Tue	112	97.5
CZ16	Aug	6	Tue	96	73.1	Jul	8	Wed	90	78.8

Table 6.2.1. Comparison of DEER Peak-Demand period definitions

The three-day demand periods for the new weather data were chosen based on these criteria:

- occurs between June 1st and September 30th,
- does not include weekdays or holidays,
- has the highest value for
  - average temperature over the three-day period **+**
  - the average temperature from noon to 6 p.m. over the three-day period **+**
  - the peak temperature over the three-day period.

As specified in the new Title-24, the assumed year for the weather files (required in order to determine which days are weekends and holidays) is 2009. The specified simulation year for the previous weather files was 1991.

The average and peak temperatures during the new peak demand periods are generally higher than those based on the previous weather files, with clear exceptions in some climate zones as seen in the following two figures.

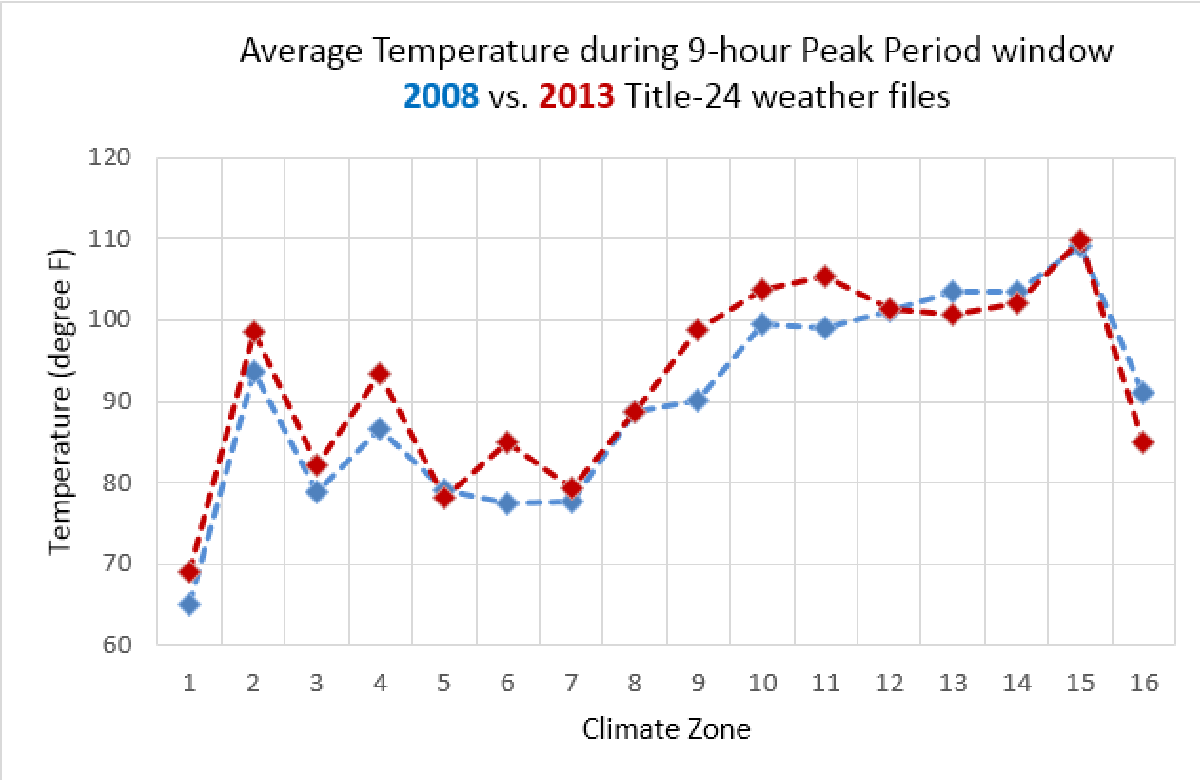

Figure 6.2.1. Comparison of the average temperature during the peak demand period

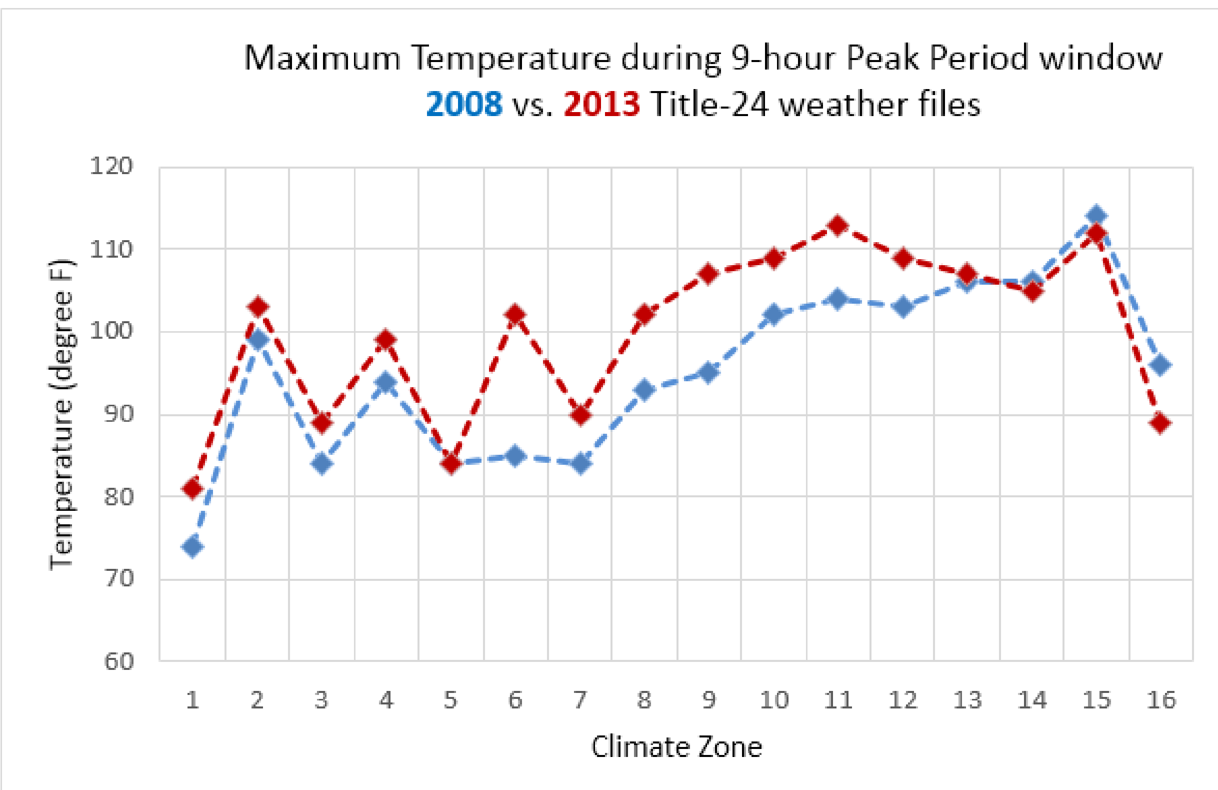

Figure 6.2.2. Comparison of the peak temperature during the peak demand period

6.3 Impacts of New CZ2010 weather data on Energy Savings

The impacts of the changes in the various weather parameters on overall energy use can be seen by examining the preliminary results for a measure that has not changed definition between the DEER2011 and DEER2014 versions.

Figure 6.3.1 shows the electric impacts for a chiller measure (water-cooled centrifugal chiller between 150 and 300 tons) using the new weather files (DEER2014) and the previous weather files (DEER2011). The kWh impacts are normalized per ton of chiller capacity.

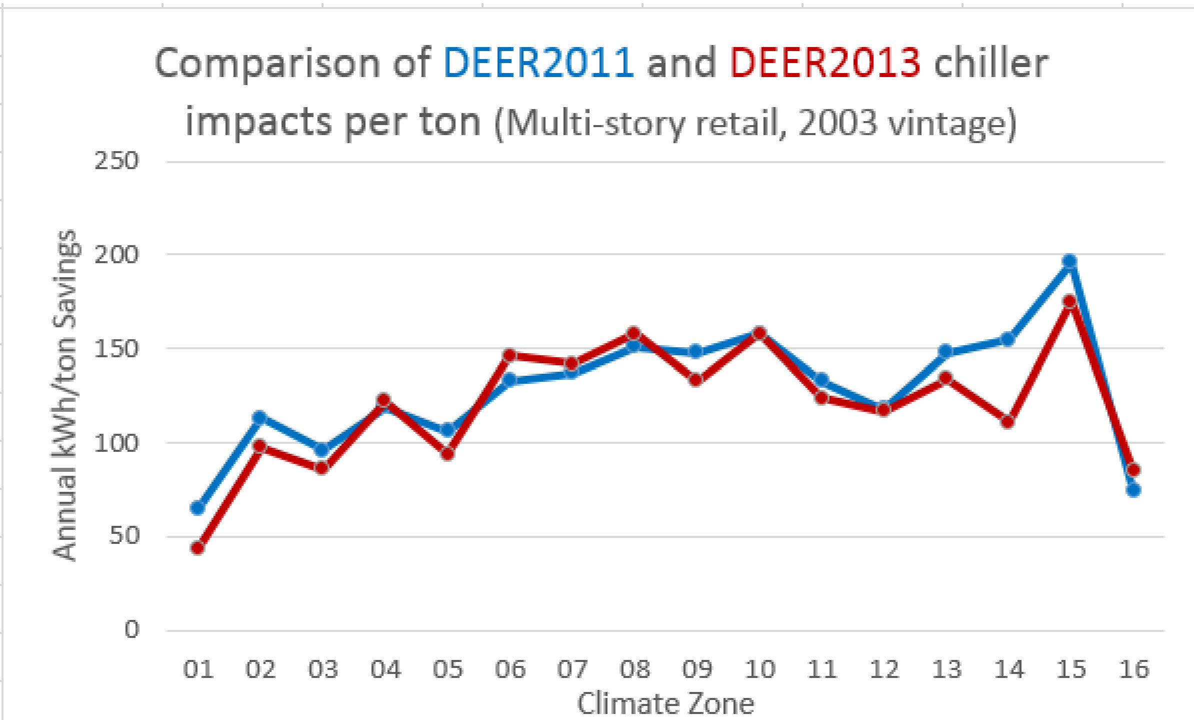

Figure 6.3.1. Comparison of Energy Impacts per Ton using new and previous weather data

The average savings per ton decreases by about 6%, with the largest decrease occurring in climate zone CZ14. Some of the difference in the unit energy impacts is due to changes in the overall cooling and heating loads and some is due to a change in the number of units (tons of cooling) that the results are normalized by.

Figure 6.3.2 below shows the same results in terms of total kWh impacts (not normalized by cooling Tons). The results for CZ14 show that total energy savings actually increased with the use of the new weather data;

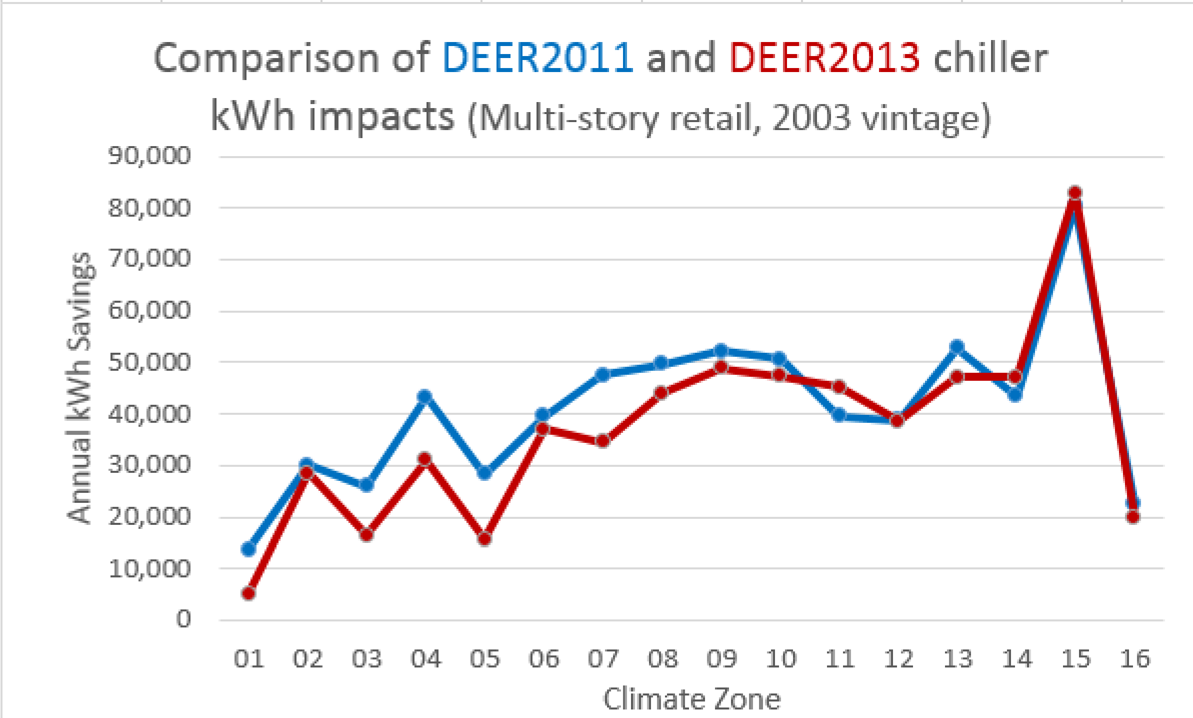

Figure 6.3.2. Comparison of Total kWh Energy Impacts using new and previous weather data

The following two figures show similar results for the same measure installed in a hospital. In these cases, the average impact per ton increases by about 1% while the total energy impacts decrease by an average of 2%.

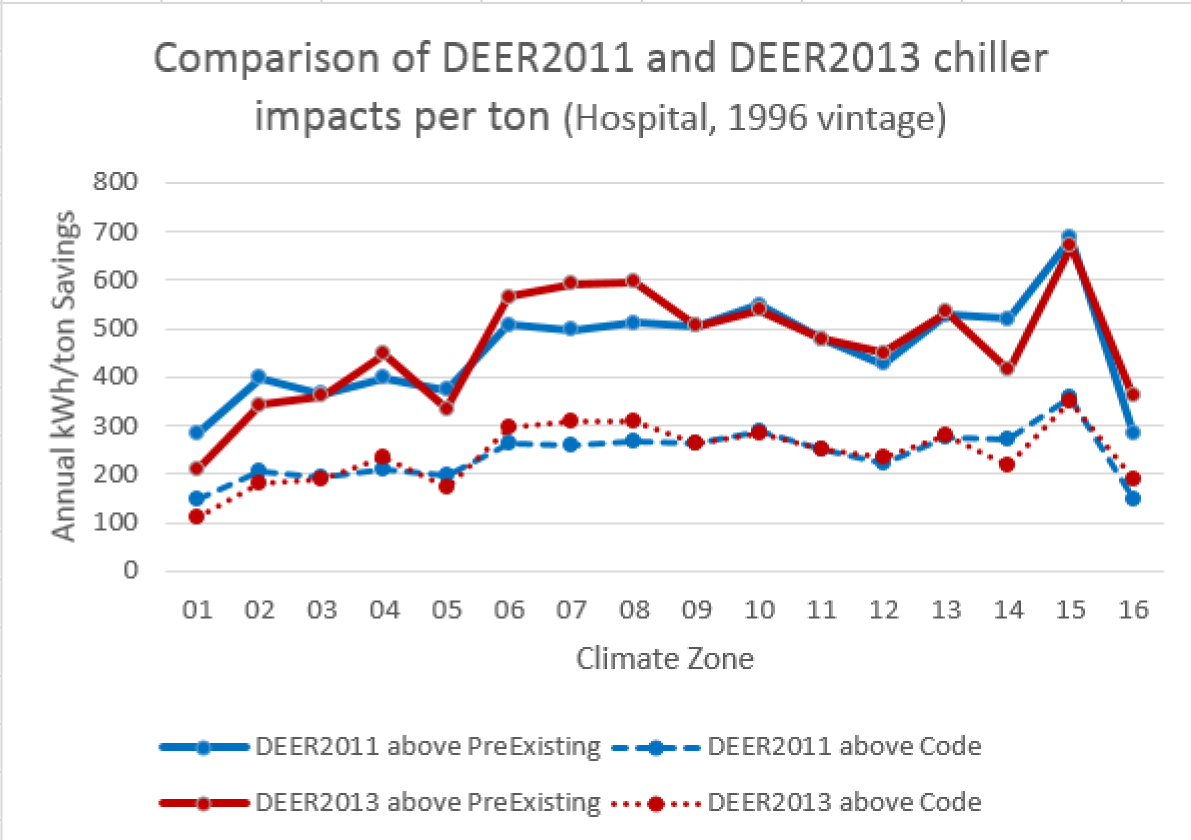

Figure 6.3.3. Comparison of Energy Impacts per Ton using new and previous weather data

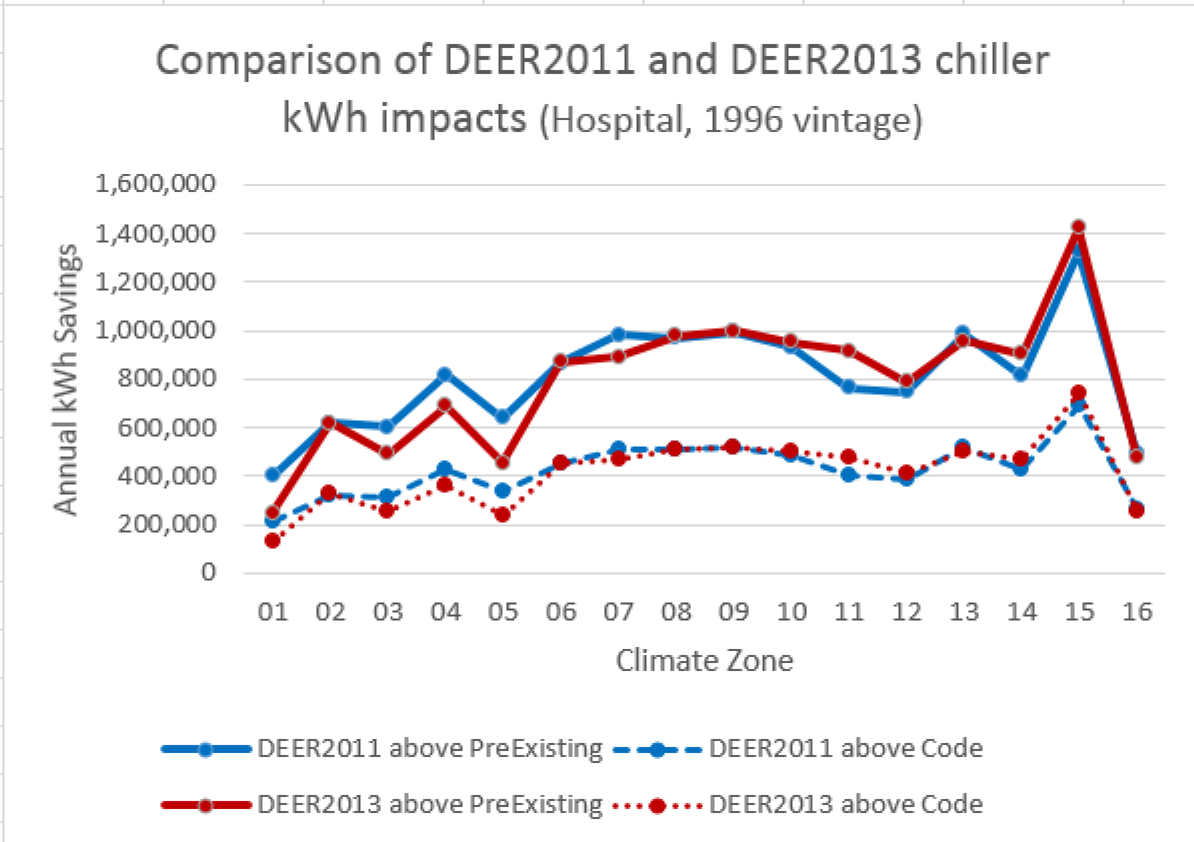

Figure 6.3.4. Comparison of Total kWh Energy Impacts using new and previous weather data