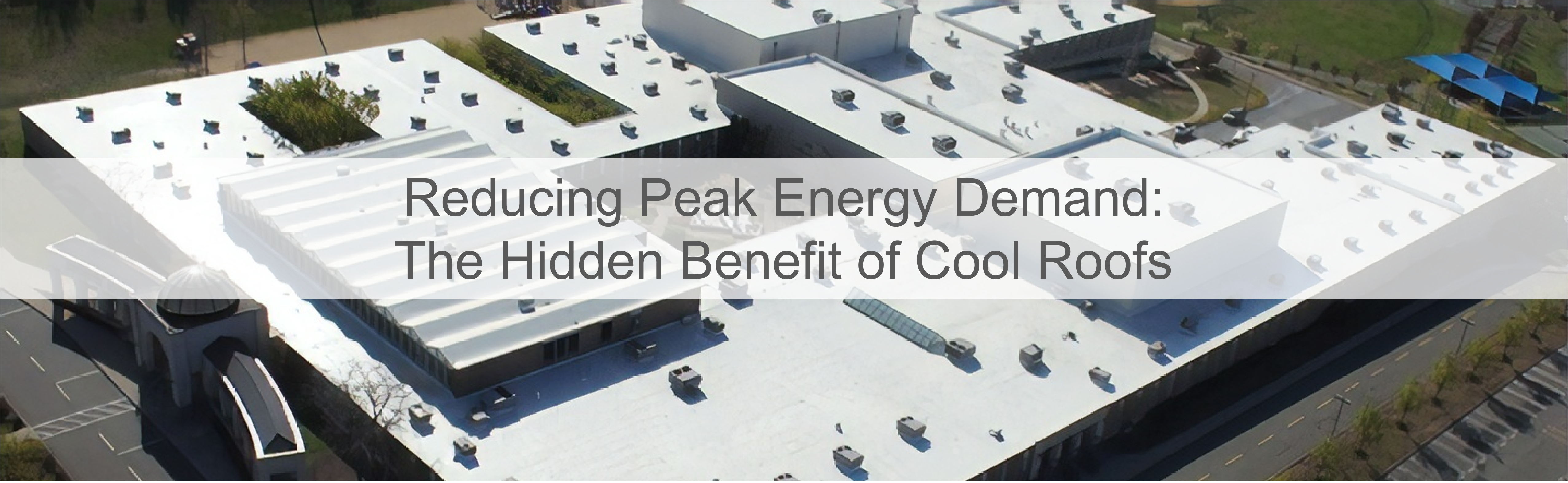

Reducing Peak Energy Demand: The Hidden Benefit of Cool Roofs

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Learning Objectives

At the end of this program, participants will be able to:

- Define peak energy demand and discuss how commercial building owners may be adversely affected by peak demand.
- Identify peak demand charges on a typical commercial electric bill and analyze peak energy demand management strategies.
- Discuss how cool roofing offers a significant benefit in reducing the energy and environmental costs associated with peak demand and how buildings in different climates can achieve the same peak savings.
- Estimate the potential savings achieved when installing a cool roof and explain how to achieve other business and community benefits associated with reducing the peak energy demand.

Purpose

Across the United States, building owners in hot and cold climates are subject to peak energy demand charges. This course examines the economic and environmental effects of peak energy demand as applied to modern buildings, focusing on how peak energy demand is incorporated into electric utility billing structures and how cool roofing yields peak demand and net energy savings for commercial buildings in all climates within North America.

Table of Contents

Introduction to Peak Energy Demand

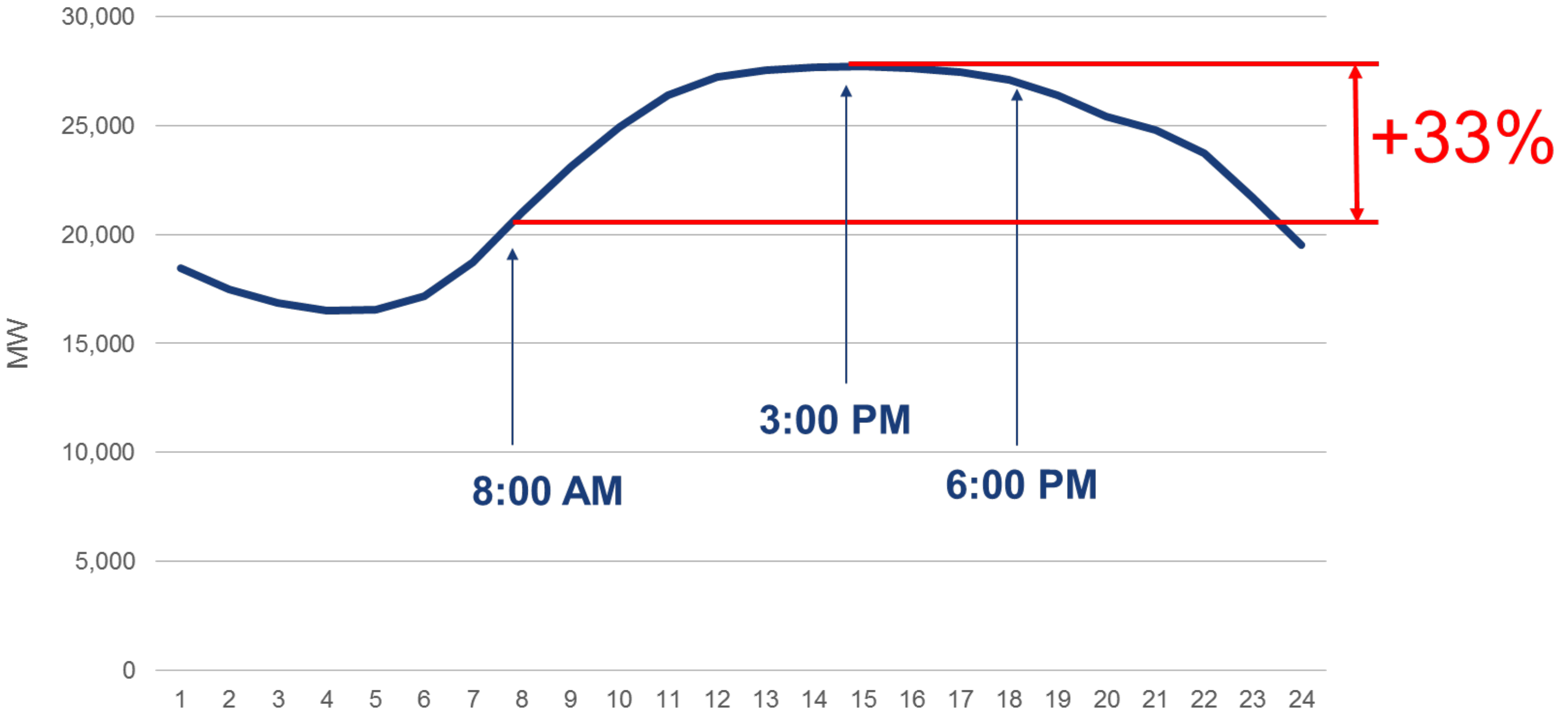
Electrical Demand

A sharp peak in electrical demand can be observed in almost every building during the busiest hours of the day. Although a share of this peak may be attributed to equipment used in the building, a significant portion is caused by increased demand for air conditioning in the heat of the afternoon. This peak in demand requires additional power plant capacity, causes imbalances in the power grid, and may result in increased air pollution. But most importantly for the building owner, peak demand may result in monthly charges many times higher than base electrical rates.

The chart on the next slide shows the hourly electrical demand for one region of the United States—in this case, the New England region of Connecticut, Rhode Island, Massachusetts, Vermont, New Hampshire, and Maine. Although this area of the country is relatively cool in the summer compared to other regions, even here peak energy demand, as measured in megawatts of electric usage, accounts for a 33% increase in base electrical rates during a typical summer day.

Example: Electrical Demand

As shown in this chart, electrical demand starts to rise between 6 and 7 AM, peaks between 3 and 4 PM, and then tapers off after 6 PM.



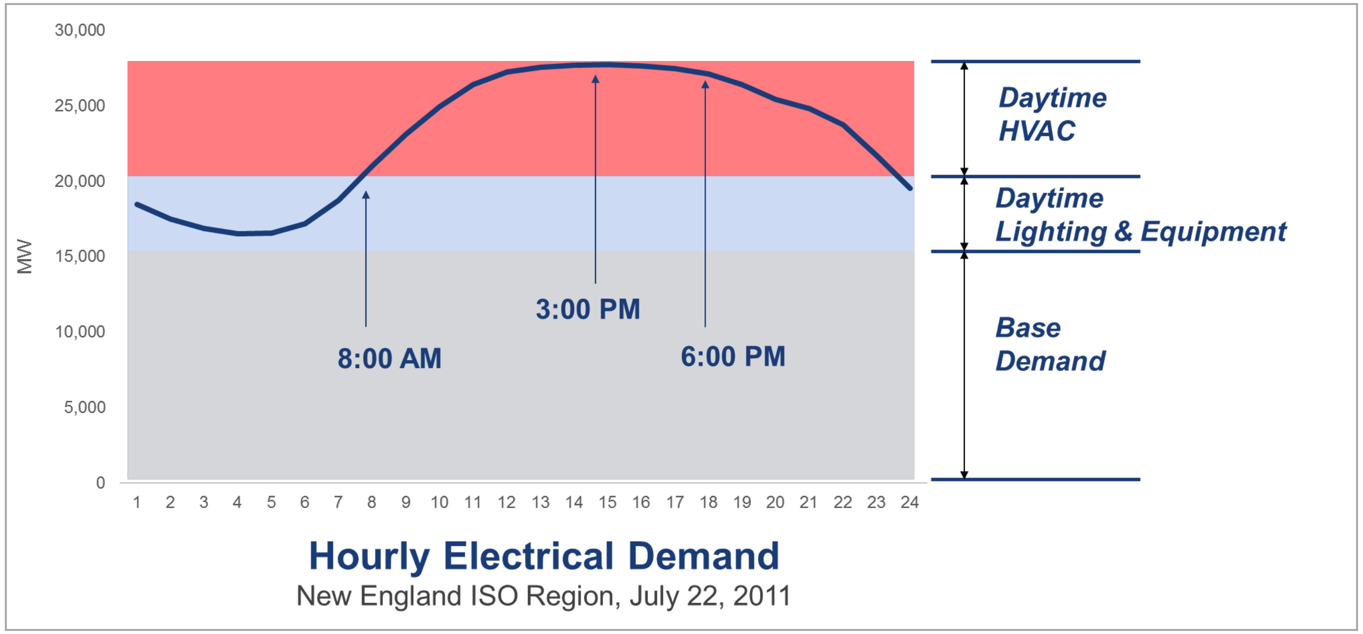
Hourly Electrical Demand

New England ISO Region, July 22, 2011

Source: US Energy Information Administration (EIA)/ISO New England (ISO/NE)

Example: Electrical Demand

Looking further at this chart, it may be easy to identify exactly what types of usage are driving this peak in demand. If one assumes that by 8:00 AM or so, the bulk of electrical equipment used in offices and factories during the day is up and running, it may be obvious that much of the peak in daily demand during the summer (or, for that matter, during any warm day regardless of the season) is most likely associated with increases in air conditioning demand. And because air conditioning demand is associated with increasing air temperatures and solar radiation during the daylight hours, it is not surprising to see this demand peak occurs in the late afternoon.



Source: US Energy Information Administration (EIA)/ISO New England (ISO/NE)

Peak Energy Demand

In addition to recognizing the immediate economics of peak demand, it is important to recognize that this electrical demand peak in the later afternoon places a number of significant burdens on the economy and the environment.

First, meeting the spike in electrical demand requires additional power plant capacity—capacity that is underutilized during nonpeak periods, which in turn leads to a reduced return on power plant investment. In addition, high peak demand may cause imbalances in the power grid, leading to possible brownouts or blackouts.

Peak energy demand is strongly associated with the overall increased heating of large cities and urban areas compared to the surrounding rural areas, commonly referred to as the urban heat island effect. The increase in energy consumption to meet peak demand may contribute to increased air pollution during a time of the day when pollution may be the most damaging in terms of ground level ozone, or smog. In turn, this may lead to increased health risks and a growing number of "ozone action days" in cities and towns across North America. One of the best approaches to shrink peak demand is to reduce the heat load on a building, especially the solar load that drives the need for air conditioning. Few heat reduction strategies can match the energy savings potential of modern cool roofing technology.

How Commercial Building Owners Are Affected by Peak Demand

Electric Bill: Two Different Charges

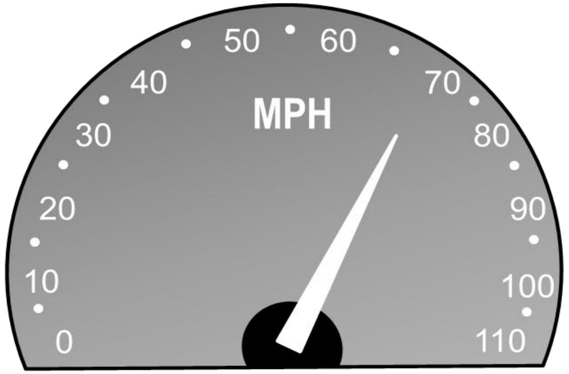
This section of the course takes a closer look at how the commercial building owner may be adversely affected by peak demand.

Although it may be convenient to focus simply on the bottom line of an electric bill, it’s important to note that hundreds of utilities across the country bill their commercial customers using a combination of two distinct types of monthly electrical charges:

- **Base energy use** measures, in kilowatt hours (**kWh**), the total quantity of electricity supplied for the billing period.
- **Peak energy demand** measures, in kilowatts (**kW**), the highest amount of power supplied at an established demand interval of 15–30 minutes within the billing period.

Base Use versus Peak Demand

One way to help understand the relationship between base energy use and peak demand load is to use the analogy of an odometer and speedometer in a car. As illustrated in this graphic, the base amount of energy used (kWh) can be compared to miles driven as shown on the odometer, while peak energy demand (kW) is similar to the top speed driven, as shown on the speedometer. Like the highest speed achieved during a trip, peak demand seldom occurs for more than a few hours or fractions of hours during each billing period.



Miles Driven = Base Use (kWh)

Top Speed = Peak Deman (kW)

Base Use versus Peak Demand

Typically, peak demand charges are based on the amount of energy consumed in a specified period of time known as a demand interval. Demand intervals are usually 15 or 30 minutes. To calculate a customer’s demand, the electric company takes the demand interval with the highest energy consumption in kilowatt hours (kWh) and divides by the length of the demand interval in hours. Mathematically, the hours cancel, leaving kilowatts (kW) as the unit of peak demand.

Commercial Electric Bills

Peak demand charges are a relatively new phenomenon in electric billing, but the concept of peak demand is closely related to a number of well-known electric power failures in the United States, including the state of California in 2000 to 2001 and the city of Chicago in 1995.

In both of these cases, peak demand for electricity during prolonged heat waves exceeded the capacity of the electric grid, causing frequent brownouts as well as occasional complete failure of the electric grid. In response to the severe effects when peak demand exceeded the capability of the electric grid, governments and utilities began to look for ways to reduce peak demand as well as pay for unused capacity at nonpeak times. This in turn has led to the incorporation of demand charges in many utility bills.

Today, there are utilities in every state that now incorporate some level of peak demand charges in their monthly bills.

Commercial Electric Bills

Utilities must have adequate capacity to meet customers’ maximum requirements, both for the total level of base energy needed and for the highest level of peak demand required. As a result, commercial and industrial electric rates across the country frequently are designed to cover the cost of providing both base and peak energy. However, identifying these two cost components on the average commercial electric bill may be a little difficult, especially when most bills are subdivided into a large number of special fees and adjustments.

Example: Typical Commercial Electric Bill

This slide shows a typical commercial electric bill containing both base use and peak demand charges, as published by an Indiana-based electrical utility.

Name/Service Address	For Inquiries Call	Account Number
Acme Enterprises Attn: Accounting Dept. 123 Main Street Hanover, IN 47243	Duke Energy 1-800-655-5555 For Account Services, please contact Betty Smith	0000-1234-05-6

Meter Number	Reading Date From	Reading Date To	Days	Meter Reading Previous	Meter Reading Present	Usage	Actual kW
Elec 012345600	Jun 28	Jul 27	29	144441	15860	56,780	120.00

Duke Energy			
Rate HSND – High Load Factor Sec S/v			
Other Charges & Credits		8.12	
Demand Charge			
120.00 kW @	$ 14.0600000	1,687.20	
Energy Charge			
56,780 kWh @	$ 0.01683000	955.61	
Rider 60 – Fuel Adjustment			
56,780 kWh @	$ 0.01420700	806.67	
Rider 61 – Coal Gasification Adj			
120.00 kW @	$ 1.91436100	229.72	
Rider 62 – Pollution Control Adj			
120.00 kW @	$ 2.04057600	244.87	
Rider 63 – Emission Allowance			
120.00 kW @	$0.00032300	18.34	
Rider 66 – DSM Ongoing			
56,780 kWh @	$ 0.00021600	12.26	
Rider 68 – Midwest Ind Sys Oper Adj			
56,780 kWh @	$ 0.00072500	41.17	
Rider 70 – Reliability Adjustment			
56,780 kWh @	$ 0.00035700	20.27	
Rider 71 – Clean Coal Adjustment			
120.00 kW @	$ 2.06452600	250.14	$ 4,274.38
Total Current Electric Charges			**$ 4,274.38**

Source: Derived from “Understanding Your Utility Bill: A Guide for Businesses in Indiana.” Duke Energy, Plainfield, Indiana, 2013.

Example: Typical Commercial Electric Bill

Near the top of the bill, monthly base energy use (circled in green) is shown to be 56,780 kWh. In the detail section of the bill, this base energy use is multiplied by a base energy charge as well as additional charges for fuel adjustments, demand side management (DSM) fees, regional system operator adjustments, and reliability adjustments.

Total Base Use:

- $1,854.32
- $0.033/kWh
- 44% of monthly bill

Name/Service Address	For Inquiries Call	Account Number
Acme Enterprises Attn: Accounting Dept. 123 Main Street Hanover, IN 47243	Duke Energy 1-800-655-5555 For Account Services, please contact Betty Smith	0000-1234-05-6

Meter Number	Reading Date From	Reading Date To	Days	Meter Reading Previous	Meter Reading Present	Usage	Actual kW
Elec 012345600	Jun 28	Jul 27	29	144441	15860	56,780	120.00

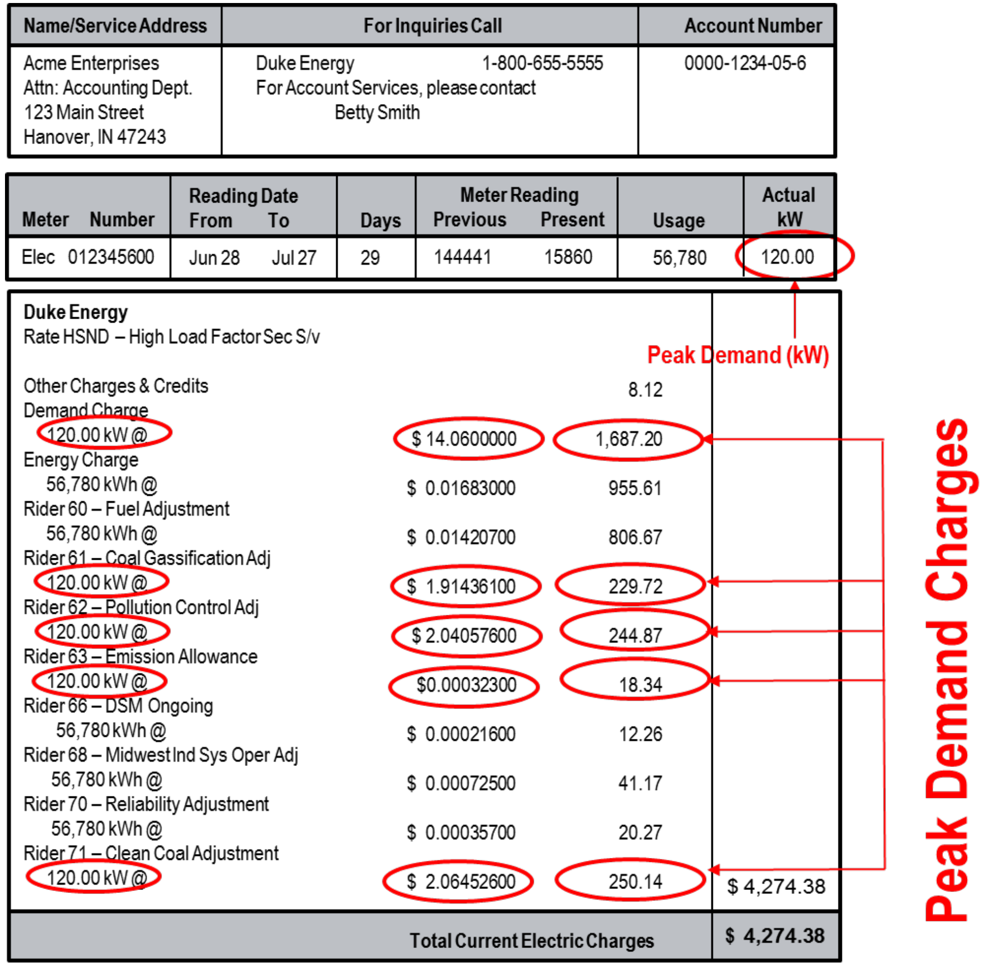
Base Use (kWh)

Base Use Charges

Duke Energy Rate HSND – High Load Factor Sec S/v			
Other Charges & Credits		8.12	
Demand Charge 120.00 kW @	$ 14.0600000	1,687.20	
Energy Charge 56,780 kWh @	$ 0.01683000	955.61	
Rider 60 – Fuel Adjustment 56,780 kWh @	$ 0.01420700	806.67	
Rider 61 – Coal Gasification Adj 120.00 kW @	$ 1.91436100	229.72	
Rider 62 – Pollution Control Adj 120.00 kW @	$ 2.04057600	244.87	
Rider 63 – Emission Allowance 120.00 kW @	$0.00032300	18.34	
Rider 66 – DSM Ongoing 56,780 kWh @	$ 0.00021600	12.26	
Rider 68 – Midwest Ind Sys Oper Adj 56,780 kWh @	$ 0.00072500	41.17	
Rider 70 – Reliability Adjustment 56,780 kWh @	$ 0.00035700	20.27	
Rider 71 – Clean Coal Adjustment 120.00 kW @	$ 2.06452600	250.14	$ 4,274.38
Total Current Electric Charges			$ 4,274.38

Source: Derived from "Understanding Your Utility Bill: A Guide for Businesses in Indiana." Duke Energy, Plainfield, Indiana, 2013.

Example: Typical Commercial Electric Bill



Name/Service Address	For Inquiries Call	Account Number
Acme Enterprises Attn: Accounting Dept. 123 Main Street Hanover, IN 47243	Duke Energy 1-800-655-5555 For Account Services, please contact Betty Smith	0000-1234-05-6

Meter Number	Reading Date From	Reading Date To	Days	Meter Reading Previous	Meter Reading Present	Usage	Actual kW
Elec 012345600	Jun 28	Jul 27	29	144441	15860	56,780	120.00

Duke Energy Rate HSND – High Load Factor Sec S/v			
Other Charges & Credits		8.12	
Demand Charge 120.00 kW @	$ 14.0600000	1,687.20	
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Rider 68 – Midwest Ind Sys Oper Adj 56,780 kWh @	$ 0.00072500	41.17	
Rider 70 – Reliability Adjustment 56,780 kWh @	$ 0.00035700	20.27	
Rider 71 – Clean Coal Adjustment 120.00 kW @	$ 2.06452600	250.14	$ 4,274.38
Total Current Electric Charges			$ 4,274.38

The base fee accounts for less than half of this total monthly electric bill. Also, near the top of the bill, peak demand (circled in red) is shown to be 120 kW. In addition to the base use fee, the 120 kW of peak demand is multiplied by a basic peak demand charge plus additional demand-related charges for coal gasification adjustments, pollution control adjustments, emission allowances, and clean coal adjustments.

Total Peak Demand:

- $2,441.94
- $20.10/kW
- 56% of monthly bill

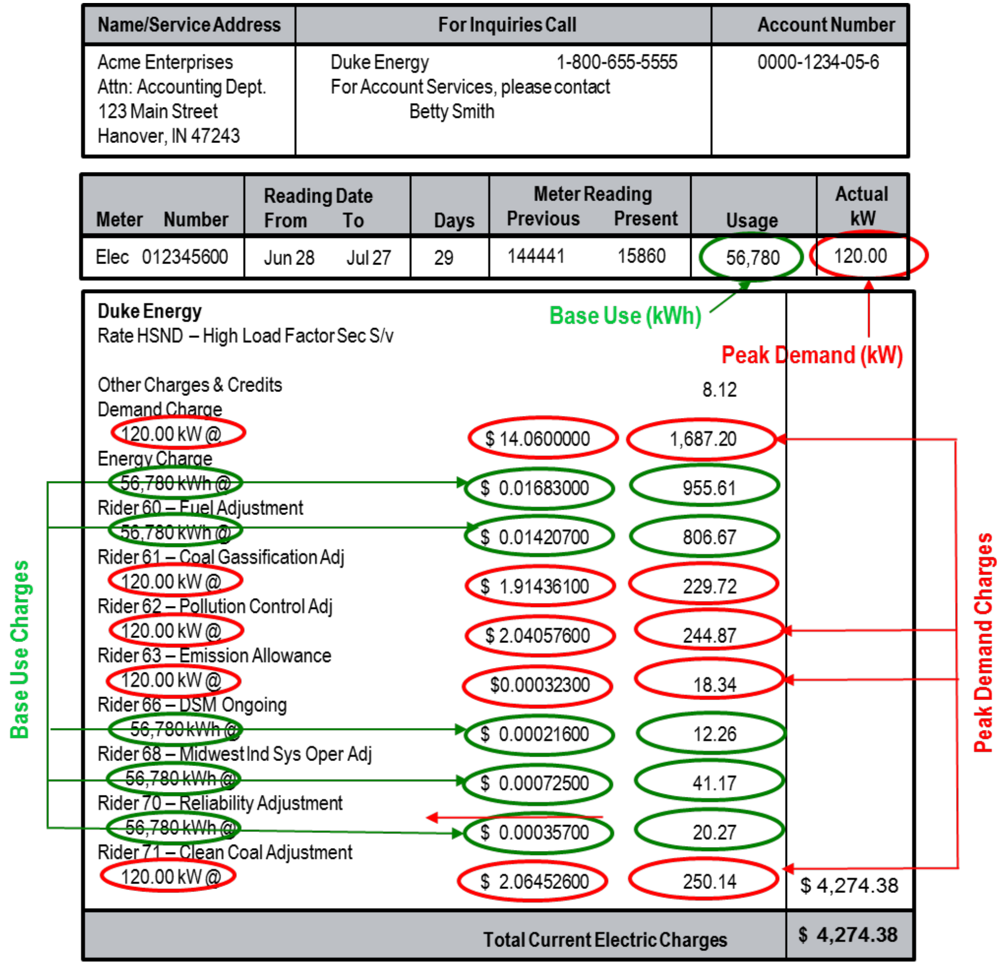
Source: Derived from "Understanding Your Utility Bill: A Guide for Businesses in Indiana." Duke Energy, Plainfield, Indiana, 2013.

Example: Typical Commercial Electric Bill

After calculating base use and peak demand charges, we also may calculate the total electricity rate for this customer.

For this bill, the total monthly charge of $4,274.38 is divided by the 56,780 kilowatt hours used, yielding an effective rate of $0.075/kWh, or over twice as much as the nominal base usage rate of $0.033.

Total Base Use:	$0.033/kWh
Total Peak Demand:	$20.10/kW
Total Net Billing:	$0.075/kWh



Name/Service Address	For Inquiries Call		Account Number
Acme Enterprises Attn: Accounting Dept. 123 Main Street Hanover, IN 47243	Duke Energy For Account Services, please contact Betty Smith	1-800-655-5555	0000-1234-05-6

Meter	Number	Reading Date From	Reading Date To	Days	Meter Reading Previous	Meter Reading Present	Usage	Actual kW
Elec	012345600	Jun 28	Jul 27	29	144441	15860	56,780	120.00

Duke Energy
Rate HSND – High Load Factor Sec S/v

Other Charges & Credits		8.12	
Demand Charge			
120.00 kW @	$ 14.0600000	1,687.20	
Energy Charge			
56,780 kWh @	$ 0.01683000	955.61	
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Rider 71 – Clean Coal Adjustment			
120.00 kW @	$ 2.06452600	250.14	$ 4,274.38
Total Current Electric Charges			$ 4,274.38

Source: Derived from "Understanding Your Utility Bill: A Guide for Businesses in Indiana." Duke Energy, Plainfield, Indiana, 2013.

Example: Typical Commercial Electric Bill

It should be noted that the total electric usage rate of $0.075/kWh in this sample bill is actually among the lowest commercial rates available in the United States. According to the U.S. Energy Information Administration (EIA), average electric rates by state for commercial users in 2013 ranged from a low of $0.07/kWh in Idaho to a high of $0.15/kWh in New York.[1]

As illustrated by this example, peak demand charges may account for a significant portion of a business's monthly electrical costs. As a consequence, building owners frequently are interested in learning how these costs may be reduced, especially through the use of energy-efficient building design and operating strategies.

[1] "Electricity Data Browser: 2013 Retail Commercial Electrical Rates by State (excluding Alaska and Hawaii)." US Energy Information Administration. For more information on average electric rates, please visit http://www.eia.gov/electricity/data/browser/. Accessed October 2020.

How to Reduce Peak Energy Demand

As mentioned previously, peak energy demand for the majority of buildings occurs in the late afternoon when occupant and building heat loads also tend to crest. For commercial facilities operating primarily during normal business hours, a number of key factors may help reduce the daily demand peak for electrical power.

First, the ubiquitous use of electrical equipment in modern buildings may add to both base and peak demand for electricity. Electrical equipment may include motors associated with manufacturing operations as well as office equipment such as computers and copying machines. Reductions in peak equipment demand may be achieved through the elimination of unnecessary equipment or by using equipment with improved electrical efficiency.

How to Reduce Peak Energy Demand

Excessive amounts of indoor lighting also add to base and peak electricity requirements. As a consequence, reducing the amount of lighting used during peak periods can be a useful strategy to reduce peak demand.

Reductions in peak demand related to lighting can be achieved through efficiency improvements such as reducing ambient lighting levels and installing task lighting, installing more efficient light fixtures, or installing automatic lighting controls to turn off lights in unused spaces. Peak lighting demand also may be offset with daylighting from windows and skylights as well as power produced through rooftop solar energy.

How to Reduce Peak Energy Demand

Although improvements in equipment and lighting and the use of clean energy sources may help reduce overall electrical demand, an important driver of peak demand in many commercial buildings is related to the spike in air conditioning loads during the heat of the afternoon.

Similar to equipment and lighting loads, peak air conditioning loads may be reduced by improving the efficiency of air conditioning systems or simply by turning up the thermostat. However, peak demand for air conditioning also may be addressed by reducing the impact of climate-related thermal loads on the building.

In the case of air conditioning loads generated by high outdoor temperatures, overall air conditioning demand can be reduced by installing additional wall and roof insulation and thermally efficient doors and windows. But a certain amount of the peak in daily air conditioning demand is related to the direct rays of the sun rather than outdoor ambient air temperatures. This means that reducing solar loads by reflecting solar heat away from the building may offer one of the best ways to reduce peak electricity demand and overall energy consumption in modern buildings.

Review Question

Why were peak demand charges instituted?

Photo by [Mihály Köles](#) on [Unsplash](#)

Review Question

Why were peak demand charges instituted?

Photo by Mihály Köles on Unsplash

Answer

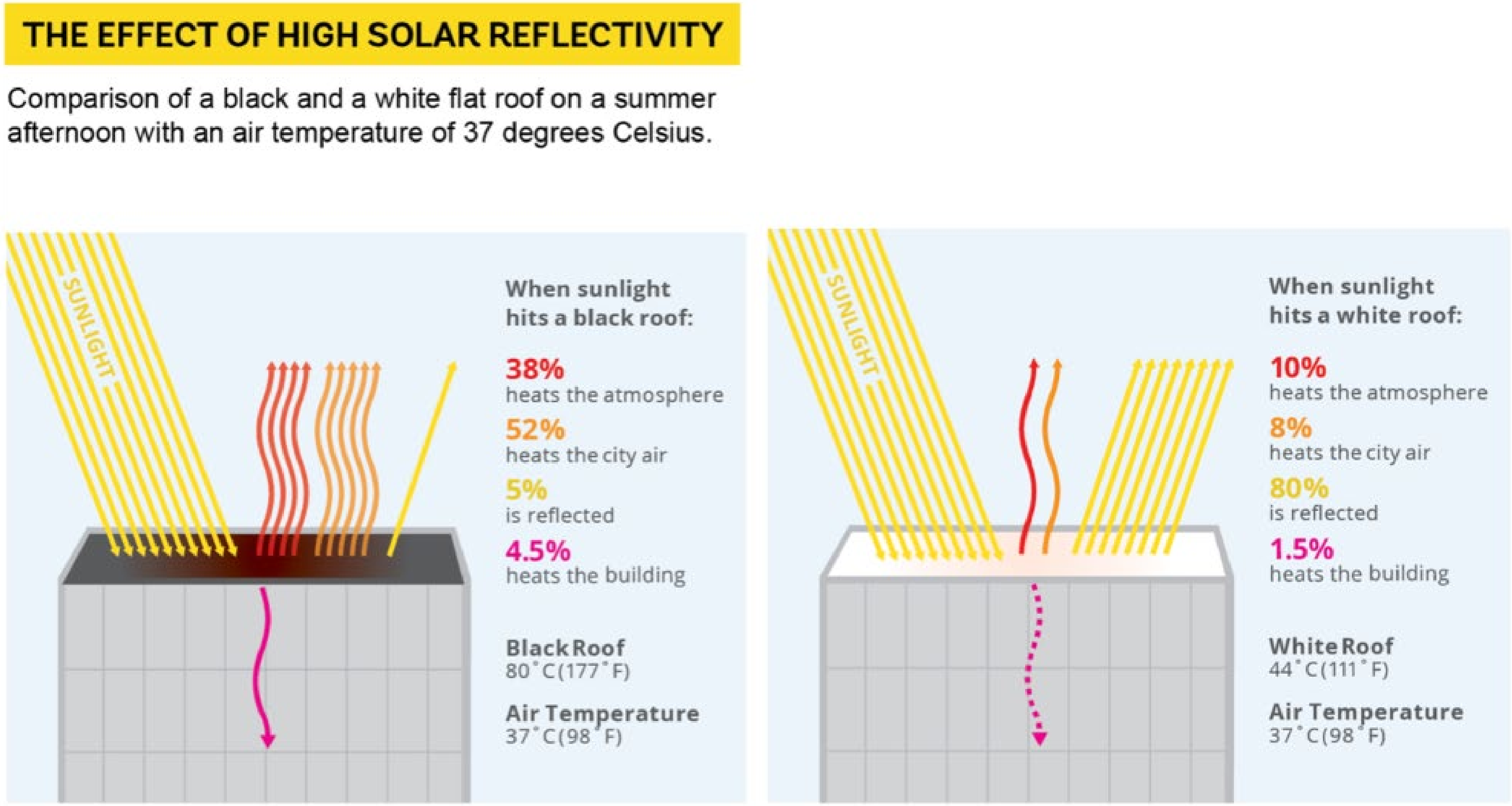
Peak demand charges were introduced when excessive amounts of energy for cooling were being used during heat waves. These new charges were a way to encourage companies to manage their peak use of electricity as well as to pay for unused capacity at nonpeak times.

Today, there are utilities in every state that now incorporate some level of peak demand charges in their monthly bills.

Cool Reflective Roofing

What Is a Cool Roof?

Reflective or “cool” roofs have proven to be an effective technology to reduce solar loads in buildings. Cool roofs use a highly reflective surface to direct a significant portion of solar heat of the sun away from the building. Unlike a dark or nonreflective roof surface that absorbs and transfers solar heat into the building, a light-colored, reflective roof surface reflects and drives solar heat away from the building and into the atmosphere.



Source: Global Cool Cities Alliance, with data from Lawrence Berkeley National Laboratory

Applicable Standards

Cool roofs are available today using a wide variety of roofing technologies, including single-ply membranes, cool-surfaced modified asphalt systems, metal roofing panels, and a wide variety of roof coatings that may be applied to many different roofing surfaces. However, for any of these roofing products to be “cool” by today’s standards, the minimum percentage of solar heat reflected away from the building typically falls within a range of 0.50 (50%) to 0.70 (70%), depending on the particular standard being applied and on the aging of the sample tested.

Applicable Standards

This table provides a brief summary of these new and aged reflectance percentages for four of the most recognized building codes and standards.

Reference Standard	Minimum Requirements for Low-Slope Roofs	
	Option 1	Option 2
International Energy Conservation Code (2018)	Aged SRI ≥ 55% and Emittance ≥ 0.75	Aged SRI ≥ 64%
ASHRAE 90.1 Energy Standard for Buildings (2016)	Reflectance ≥ 55% and Emittance ≥ 0.75	Aged SRI ≥ 64%
ENERGY STAR® for Roofs (US EPA, 2020)**	Solar reflectance ≥ 65%	Aged solar reflectance ≥ 50%
California Title 24 Energy Standard (2016)	Aged reflectance ≥ 63% and Emittance ≥ 0.75	Aged SRI ≥ 75%

Current Cool Roof Reflectance Standards*

*Although stated as a percentage in this table, roof reflectivity is typically expressed as a ratio in reference standards. Initial values shown are based on measurements of roofing material as manufactured, while aged values shown are based on measurements after field exposure of test samples. Roofing manufacturers typically identify the reflectivity of their products in technical data sheets and brochures. In almost all cases, these measures of roof reflectance are based on standards developed by EPA's ENERGY STAR program and the ANSI/CRRC-1 Cool Roof Standard developed by the Cool Roof Rating Council (CRRC). The EPA and the CRRC maintain online databases of the initial and aged reflectivity of many roofing products.

**The US EPA announced the ENERGY STAR for Roof Products program will end on June 1, 2022.

For more information on ENERGY STAR rated roofing products, please visit https://www.energystar.gov/products/building_products/roof_products. (Accessed October 2020.)

For more information on Cool Roof Rating Council rated roofing products, please visit http://coolroofs.org/products/results. (Accessed October 2020.)

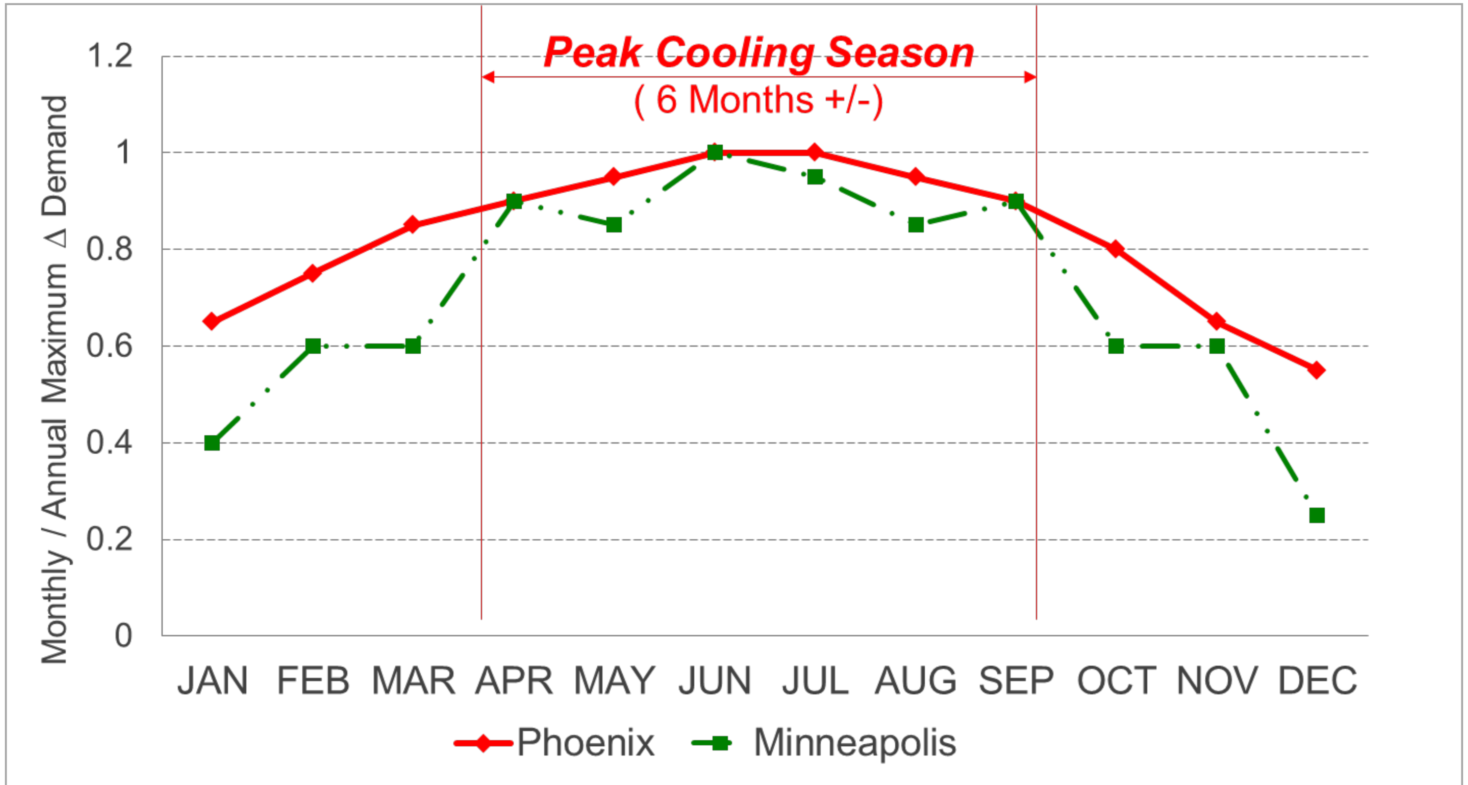
Peak Demand Is Not Just a Warm Climate Issue

In order to better understand the benefits of cool roofs in reducing peak energy demand, researchers at Oak Ridge National Laboratory (ORNL) examined the seasonal variation in peak air conditioning demand for a variety of different climates across North America. Their findings suggest that even though base cooling demand may be higher in hot climates as compared to cooler climates, almost all climates exhibit a seasonal variation in the peaks for roof-related air conditioning demand.

The chart on the next slide compares this seasonal trend for a hot, cooling-oriented climate (Phoenix) to that of a cold, heating-oriented climate (Minneapolis). Although Phoenix exhibits a higher and more consistent monthly demand for air conditioning as compared to Minneapolis, demand falls off at the beginning and end of the year for both cities, with a substantial portion of peak demand located within a six-month period from April to September. As a result, it may be possible to reduce peak demand in both cities using cool roofing technologies. In fact, a recent study of cool roofs and peak demand costs suggests that the potential for roof-related peak demand savings for hotter cities like Phoenix and colder cities like Minneapolis may be approximately identical.[1]

[1]Petrie, T. W., K. E. Wilkes, and A. O. Desjarlais. "Effects of Solar Radiation Control on Electricity Demand Charges—An Addition to the DOE Cool Roof Calculator." Proceedings of the Performance of the Exterior Envelope of Whole Buildings IX International Conference, December 5–10, 2004. https://web.ornl.gov/sci/buildings/conf-archive/2004%20B9%20papers/064_Petrie.pdf. Accessed October 2020.

Peak Demand Is Not Just a Warm Climate Issue

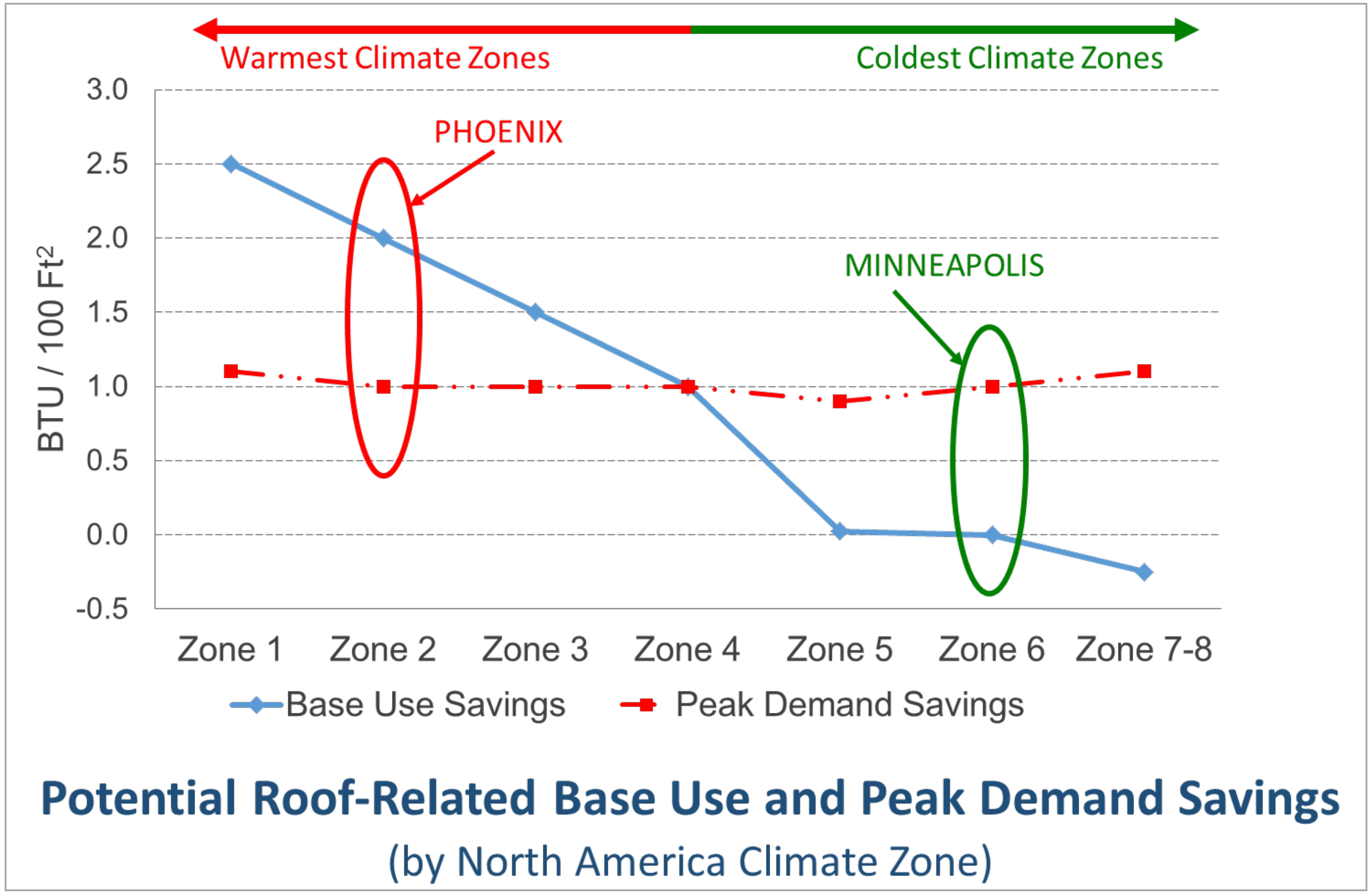


Roof-Related Air Conditioning Demand:
Ratio of Monthly to Annual Peak

Source: Oak Ridge National Laboratory (ORNL)

Peak Demand Savings: Uniform Through All Climate Zones

This figure illustrates the comparative base energy and peak demand savings for the seven major climate zones in the United States identified in this study.

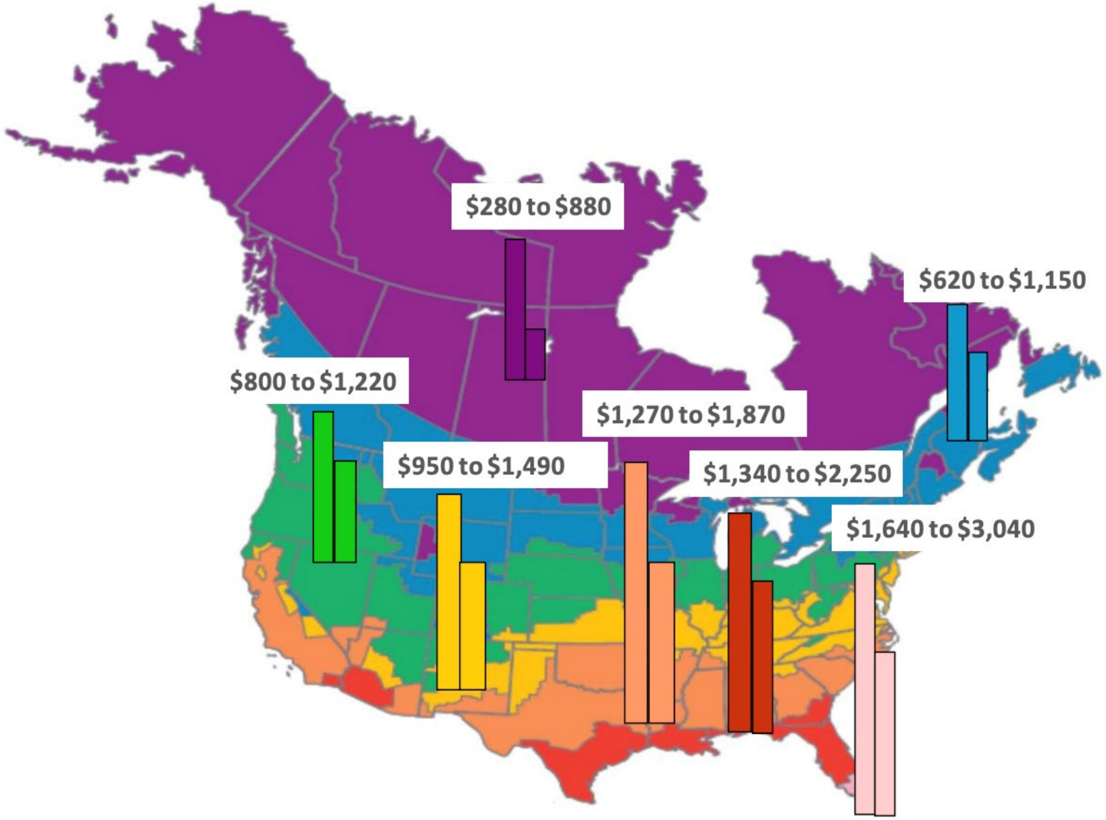


Source: RoofPoint Energy and Carbon Calculator, Center for Environmental Innovation in Roofing

Peak Demand Savings: Uniform Through All Climate Zones

Although the colder climate zone of Minneapolis offers little or no savings potential in terms of base use, the opportunity for peak demand savings is approximately the same as in much hotter climate zones. Although it may seem counterintuitive that peak energy savings similar to those in hot climates may be achieved in cold climates, the charts on the previous two slides, taken together, may help explain this apparent paradox.

In a hot location such as Phoenix, even though overall cooling loads are very high, the seasonal peak is less pronounced, while the seasonal peak in a cold location such as Minneapolis is much more pronounced even though the overall cooling loads are smaller. In effect, peak demand savings in hot climates may be described as a smaller piece of a larger pie, while peak demand savings in cold climates may be described as a larger piece of a smaller pie.



Estimated Range of Net Energy Savings for a Cool Roof by Climate Zone
(Annual dollars per 20,000-square-foot roof area)

Cool Roof Calculator

In response to the opportunity to reduce peak demand through the use of cool roofing, the US Department of Energy (DOE) has created an online calculator specifically designed to evaluate peak demand and cool roofs. This version of the main calculator is for large facilities that purchase electricity with a demand charge based on peak monthly load.

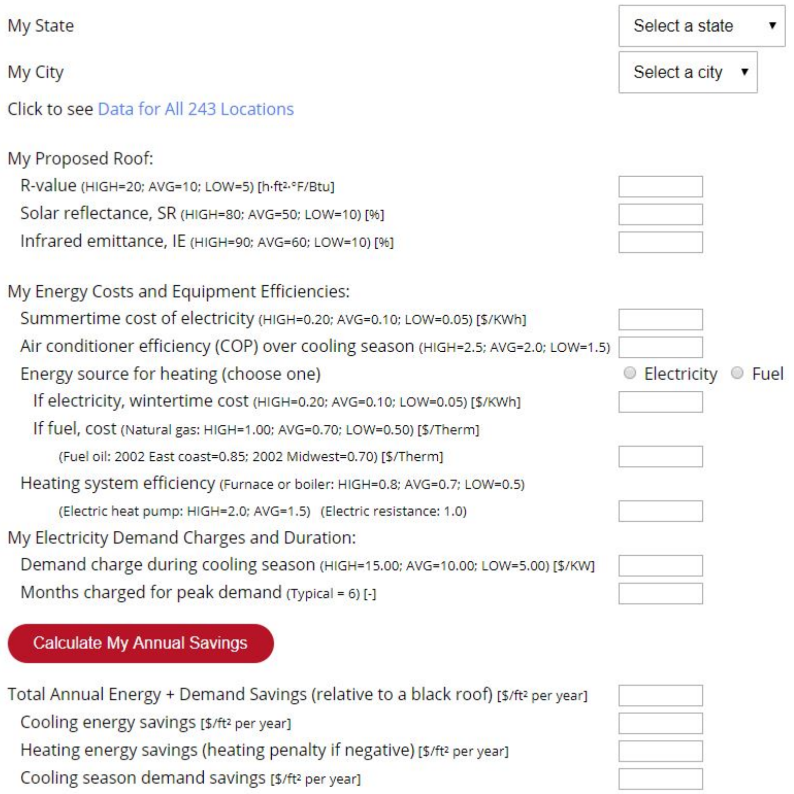
The Cool Roof Calculator, developed by the Oak Ridge National Laboratory, provides a fast and easy way to compare the overall energy costs and savings for a wide variety of roof and building conditions. Because the DOE Cool Roof Calculator includes climate data for over 200 cities across North America, it's easy to find a model location that can match up with almost any site in the United States or Canada.

The Cool Roof Calculator models the typical low-slope commercial roof with insulation placed directly over the deck and under the roofing membrane. In all cases, the Cool Roof Calculator models the benefits of a cool reflective roof (which as we previously discussed runs anywhere from 50% to 70% reflectivity) compared to a nominal black roof with a 5% reflectivity.

(Links accessed October 2020.)

Using the DOE Cool Roof Calculator

Using the DOE Cool Roof Calculator is simple and straightforward. To get started, you just navigate to the designated webpage sponsored by DOE and ORNL using this link, http://web.ornl.gov/sci/buildings/tools/cool-roof/peak/ (Accessed October 2020).


My State — Select a state
My City — Select a city
Click to see Data for All 243 Locations

My Proposed Roof:
R-value (HIGH=20; AVG=10; LOW=5) [h·ft²·°F/Btu]
Solar reflectance, SR (HIGH=80; AVG=50; LOW=10) [%]
Infrared emittance, IE (HIGH=90; AVG=60; LOW=10) [%]

My Energy Costs and Equipment Efficiencies:
Summertime cost of electricity (HIGH=0.20; AVG=0.10; LOW=0.05) [$/KWh]
Air conditioner efficiency (COP) over cooling season (HIGH=2.5; AVG=2.0; LOW=1.5)
Energy source for heating (choose one) — Electricity / Fuel
If electricity, wintertime cost (HIGH=0.20; AVG=0.10; LOW=0.05) [$/KWh]
If fuel, cost (Natural gas: HIGH=1.00; AVG=0.70; LOW=0.50) [$/Therm]
(Fuel oil: 2002 East coast=0.85; 2002 Midwest=0.70) [$/Therm]
Heating system efficiency (Furnace or boiler: HIGH=0.8; AVG=0.7; LOW=0.5)
(Electric heat pump: HIGH=2.0; AVG=1.5) (Electric resistance: 1.0)
My Electricity Demand Charges and Duration:
Demand charge during cooling season (HIGH=15.00; AVG=10.00; LOW=5.00) [$/KW]
Months charged for peak demand (Typical = 6) [-]

Calculate My Annual Savings

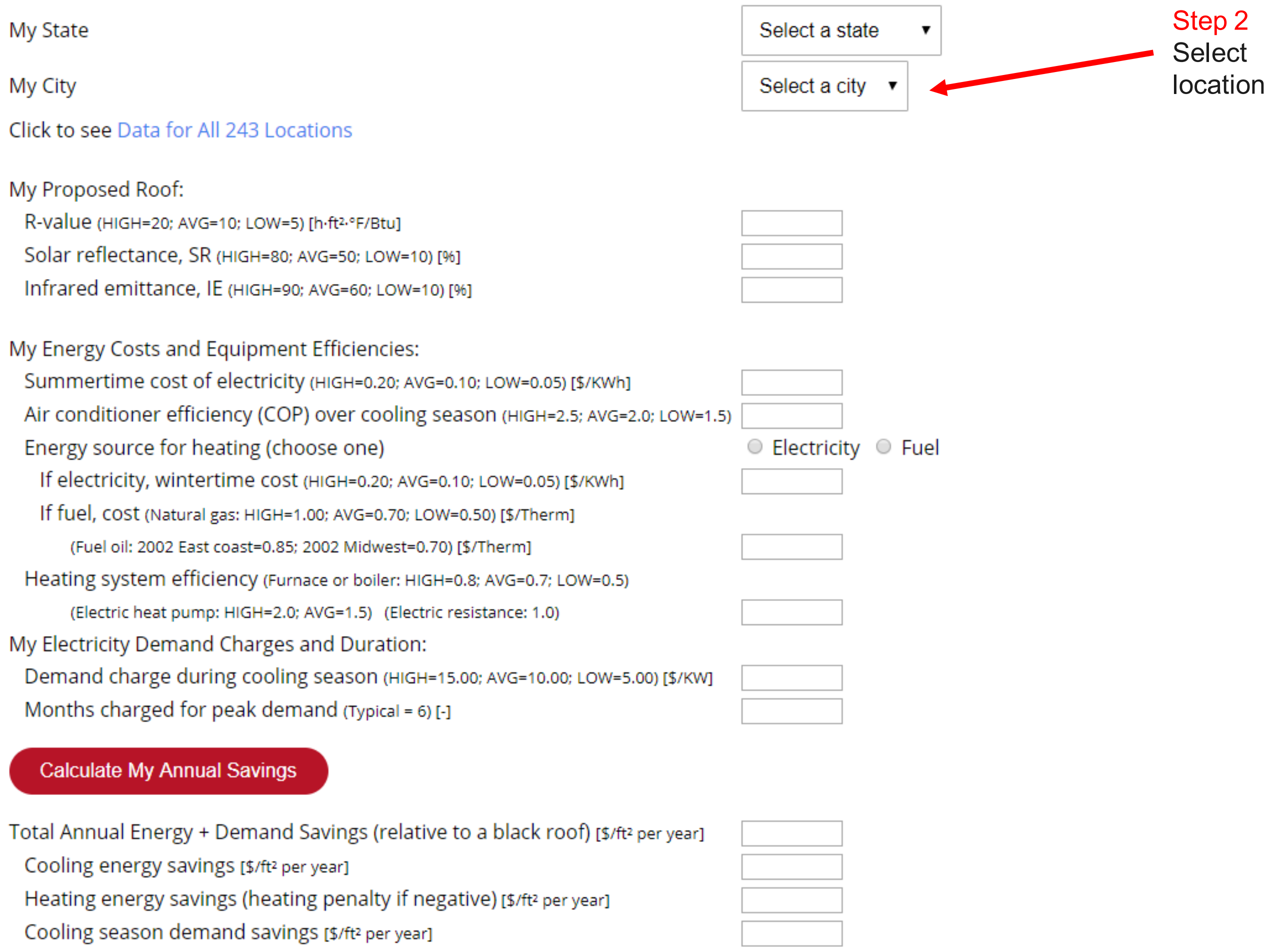
Total Annual Energy + Demand Savings (relative to a black roof) [$/ft² per year]
Cooling energy savings [$/ft² per year]
Heating energy savings (heating penalty if negative) [$/ft² per year]
Cooling season demand savings [$/ft² per year]

Step 1 Go to Cool Roof Calculator webpage

Using the DOE Cool Roof Calculator

Next, you select a United States state or a Canadian province, and then select the closest city from a list provided for each state or province.

For all states, an ample number of model cities is provided to allow users in other cities to make accurate climate-based comparisons. As an example, the state of Ohio includes data for Akron, Cleveland, Dayton, Mansfield, Toledo, and Youngstown.



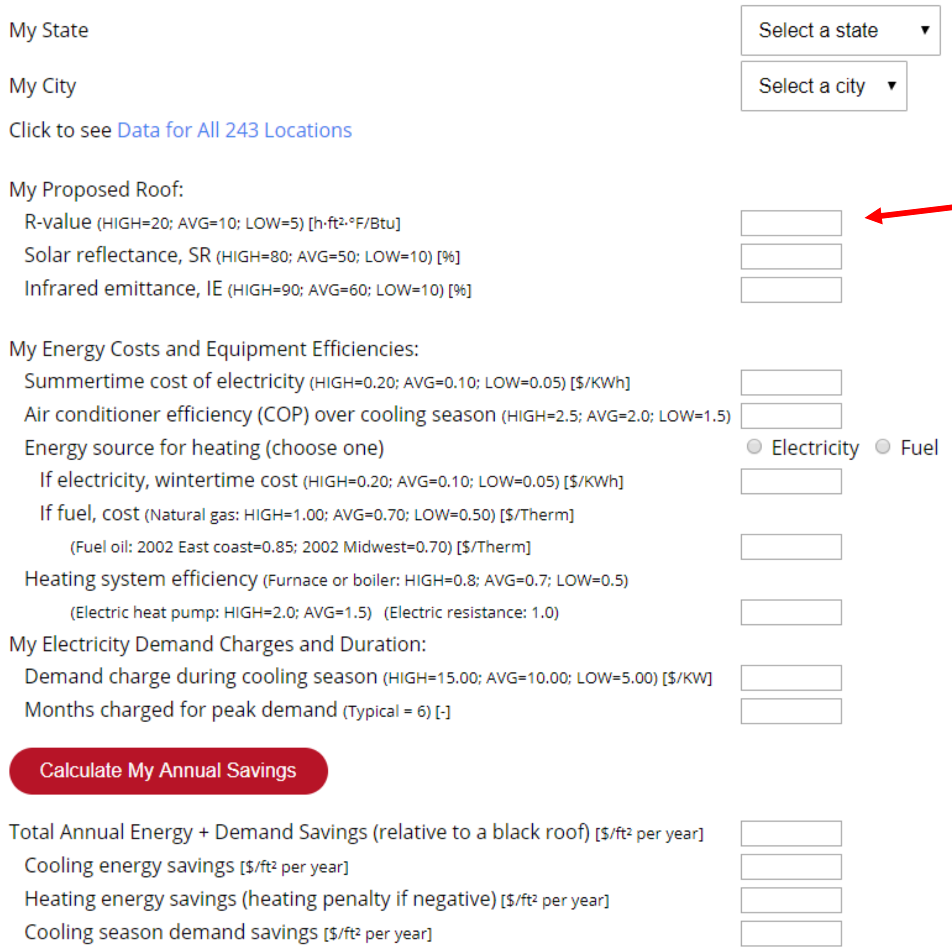
DOE Cool Roof Calculator
http://web.ornl.gov/sci/buildings/tools/cool-roof/peak/
(Accessed October 2020)

Using the DOE Cool Roof Calculator

Next, the proposed R-value of the roof is entered.

If the calculator is being used by a building or roofing professional familiar with past and current energy codes, it is likely that the roof R-value may be estimated based on the age of the roof or building.

For the nonprofessional, the calculator instructions provide suggestions for “high,” “average,” and “low” insulation R-value levels across North America.



My State — Select a state

My City — Select a city

Click to see Data for All 243 Locations

My Proposed Roof:

- R-value (HIGH=20; AVG=10; LOW=5) [h·ft²·°F/Btu]
- Solar reflectance, SR (HIGH=80; AVG=50; LOW=10) [%]
- Infrared emittance, IE (HIGH=90; AVG=60; LOW=10) [%]

My Energy Costs and Equipment Efficiencies:

- Summertime cost of electricity (HIGH=0.20; AVG=0.10; LOW=0.05) [$/KWh]
- Air conditioner efficiency (COP) over cooling season (HIGH=2.5; AVG=2.0; LOW=1.5)
- Energy source for heating (choose one) — Electricity / Fuel
  - If electricity, wintertime cost (HIGH=0.20; AVG=0.10; LOW=0.05) [$/KWh]
  - If fuel, cost (Natural gas: HIGH=1.00; AVG=0.70; LOW=0.50) [$/Therm]
    (Fuel oil: 2002 East coast=0.85; 2002 Midwest=0.70) [$/Therm]
- Heating system efficiency (Furnace or boiler: HIGH=0.8; AVG=0.7; LOW=0.5)
  (Electric heat pump: HIGH=2.0; AVG=1.5) (Electric resistance: 1.0)

My Electricity Demand Charges and Duration:

- Demand charge during cooling season (HIGH=15.00; AVG=10.00; LOW=5.00) [$/KW]
- Months charged for peak demand (Typical = 6) [-]

Calculate My Annual Savings

Total Annual Energy + Demand Savings (relative to a black roof) [$/ft² per year]

- Cooling energy savings [$/ft² per year]
- Heating energy savings (heating penalty if negative) [$/ft² per year]
- Cooling season demand savings [$/ft² per year]

Step 3
Enter proposed R-value

DOE Cool Roof Calculator
http://web.ornl.gov/sci/buildings/tools/cool-roof/peak/
(Accessed October 2020)

Using the DOE Cool Roof Calculator

The solar reflectance (SR) value for a specific roofing product may be obtained from manufacturer data sheets or from the ENERGY STAR or CRRC websites (see resources section for more info).

The calculator provides suggestions for high, average, and low SR values. It should be noted that the aged reflectance value should be used in order to accurately estimate the long-term ability of the roof to reflect solar energy.

DOE Cool Roof Calculator
http://web.ornl.gov/sci/buildings/tools/cool-roof/peak/
(Accessed October 2020)

My State — Select a state ▾

My City — Select a city ▾

Click to see Data for All 243 Locations

My Proposed Roof:
- R-value (HIGH=20; AVG=10; LOW=5) [h·ft²·°F/Btu]
- Solar reflectance, SR (HIGH=80; AVG=50; LOW=10) [%]
- Infrared emittance, IE (HIGH=90; AVG=60; LOW=10) [%]

Step 4
Enter
SR value

My Energy Costs and Equipment Efficiencies:
- Summertime cost of electricity (HIGH=0.20; AVG=0.10; LOW=0.05) [$/KWh]
- Air conditioner efficiency (COP) over cooling season (HIGH=2.5; AVG=2.0; LOW=1.5)
- Energy source for heating (choose one) — Electricity / Fuel
  - If electricity, wintertime cost (HIGH=0.20; AVG=0.10; LOW=0.05) [$/KWh]
  - If fuel, cost (Natural gas: HIGH=1.00; AVG=0.70; LOW=0.50) [$/Therm]
    - (Fuel oil: 2002 East coast=0.85; 2002 Midwest=0.70) [$/Therm]
- Heating system efficiency (Furnace or boiler: HIGH=0.8; AVG=0.7; LOW=0.5)
  - (Electric heat pump: HIGH=2.0; AVG=1.5) (Electric resistance: 1.0)

My Electricity Demand Charges and Duration:
- Demand charge during cooling season (HIGH=15.00; AVG=10.00; LOW=5.00) [$/KW]
- Months charged for peak demand (Typical = 6) [-]

Calculate My Annual Savings

Total Annual Energy + Demand Savings (relative to a black roof) [$/ft² per year]
- Cooling energy savings [$/ft² per year]
- Heating energy savings (heating penalty if negative) [$/ft² per year]
- Cooling season demand savings [$/ft² per year]

Using the DOE Cool Roof Calculator

Roof infrared emittance (IE) for a roofing product may be obtained from manufacturer data sheets or from the ENERGY STAR or CRRC websites. The calculator provides suggestions for high, average, and low IE values. However, the values shown on the calculator may provide a much wider range than typically found in most low-slope roofing membranes. Typically, the IE of common single-ply and asphaltic roof coverings runs within a range of 0.75 to 0.90.

My State — Select a state ▾

My City — Select a city ▾

Click to see Data for All 243 Locations

My Proposed Roof:

- R-value (HIGH=20; AVG=10; LOW=5) [h·ft²·°F/Btu]
- Solar reflectance, SR (HIGH=80; AVG=50; LOW=10) [%]
- Infrared emittance, IE (HIGH=90; AVG=60; LOW=10) [%]

Step 5
Enter
IE value

My Energy Costs and Equipment Efficiencies:

- Summertime cost of electricity (HIGH=0.20; AVG=0.10; LOW=0.05) [$/KWh]
- Air conditioner efficiency (COP) over cooling season (HIGH=2.5; AVG=2.0; LOW=1.5)
- Energy source for heating (choose one) — Electricity / Fuel
  - If electricity, wintertime cost (HIGH=0.20; AVG=0.10; LOW=0.05) [$/KWh]
  - If fuel, cost (Natural gas: HIGH=1.00; AVG=0.70; LOW=0.50) [$/Therm]
    (Fuel oil: 2002 East coast=0.85; 2002 Midwest=0.70) [$/Therm]
- Heating system efficiency (Furnace or boiler: HIGH=0.8; AVG=0.7; LOW=0.5)
  (Electric heat pump: HIGH=2.0; AVG=1.5) (Electric resistance: 1.0)

My Electricity Demand Charges and Duration:

- Demand charge during cooling season (HIGH=15.00; AVG=10.00; LOW=5.00) [$/KW]
- Months charged for peak demand (Typical = 6) [-]

Calculate My Annual Savings

DOE Cool Roof Calculator
http://web.ornl.gov/sci/buildings/tools/cool-roof/peak/
(Accessed October 2020)

Please note, a full discussion of IE is beyond the scope of this presentation, but essentially it is a measure of the amount of solar energy absorbed into the roof but eventually transmitted back to the atmosphere (rather than into the building).

Using the DOE Cool Roof Calculator

The calculator assumes that the building is being heated in the winter and cooled (by electricity) in the summer, but the user must identify the types of fuel used to heat and cool the building as required. Because the calculator assumes electricity will be used to cool the building, the user must enter the “summertime” cost of electricity in $/kWh, which is identical to the base use rate discussed previously. (Note that the peak demand charge for electricity is entered later in the calculation.)

Next, the type of fuel (electricity, natural gas, or fuel oil) used to heat the building as well as the wintertime cost of the fuel must be entered. In the case of electricity, the cost is measured in $/kWh and is the same as the base use rate, as determined from an electric bill. For natural gas and fuel oil, the cost is measured in therms. Again, the calculator provides a suggested range of typical fuel prices across North America.

Using the DOE Cool Roof Calculator

After identifying the types of fuel and their corresponding unit costs, the user must enter the efficiency for the air conditioning and heating equipment used in the building. Suggested efficiencies are provided in the calculator instructions.

My State — Select a state

My City — Select a city

Click to see Data for All 243 Locations

My Proposed Roof:

- R-value (HIGH=20; AVG=10; LOW=5) [h·ft²·°F/Btu]
- Solar reflectance, SR (HIGH=80; AVG=50; LOW=10) [%]
- Infrared emittance, IE (HIGH=90; AVG=60; LOW=10) [%]

My Energy Costs and Equipment Efficiencies:

- Summertime cost of electricity (HIGH=0.20; AVG=0.10; LOW=0.05) [$/KWh]
- Air conditioner efficiency (COP) over cooling season (HIGH=2.5; AVG=2.0; LOW=1.5)
- Energy source for heating (choose one) — Electricity / Fuel
  - If electricity, wintertime cost (HIGH=0.20; AVG=0.10; LOW=0.05) [$/KWh]
  - If fuel, cost (Natural gas: HIGH=1.00; AVG=0.70; LOW=0.50) [$/Therm]
    (Fuel oil: 2002 East coast=0.85; 2002 Midwest=0.70) [$/Therm]
- Heating system efficiency (Furnace or boiler: HIGH=0.8; AVG=0.7; LOW=0.5)
  (Electric heat pump: HIGH=2.0; AVG=1.5) (Electric resistance: 1.0)

My Electricity Demand Charges and Duration:

- Demand charge during cooling season (HIGH=15.00; AVG=10.00; LOW=5.00) [$/KW]
- Months charged for peak demand (Typical = 6) [-]

Calculate My Annual Savings

Total Annual Energy + Demand Savings (relative to a black roof) [$/ft² per year]

- Cooling energy savings [$/ft² per year]
- Heating energy savings (heating penalty if negative) [$/ft² per year]
- Cooling season demand savings [$/ft² per year]

Step 6
Enter base energy costs

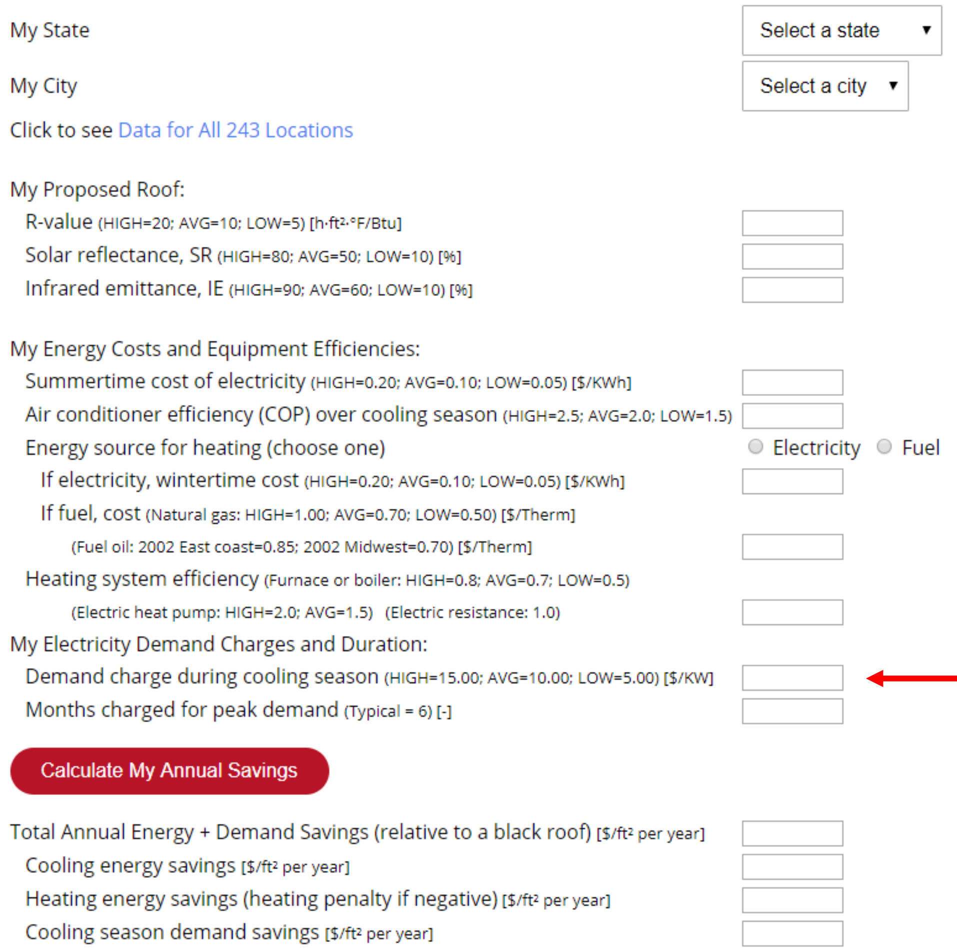
Step 7
Enter equipment efficiencies

DOE Cool Roof Calculator
http://web.ornl.gov/sci/buildings/tools/cool-roof/peak/
(Accessed October 2020)

Using the DOE Cool Roof Calculator

Next, the peak demand charge for the building, in $/kW, must be entered. This demand charge should be determined from a recent electric bill. Be sure to add all portions of the bill related to peak demand charges, as illustrated on the example of a typical commercial electric bill shown earlier in this presentation.

Finally, the duration (typically six months) of the peak air conditioning season for the building must be entered.



Step 8
Enter electricity demand charges and duration

DOE Cool Roof Calculator
http://web.ornl.gov/sci/buildings/tools/cool-roof/peak/
(Accessed October 2020)

Using the DOE Cool Roof Calculator

Based on the information provided by the user, the Cool Roof Calculator will provide an estimate of the total roof-related energy and demand savings for the building and roof system selected.

My State	Select a state ▾
My City	Select a city ▾
Click to see Data for All 243 Locations	
My Proposed Roof:	
R-value (HIGH=20; AVG=10; LOW=5) [h·ft^{2}·°F/Btu]	
Solar reflectance, SR (HIGH=80; AVG=50; LOW=10) [%]	
Infrared emittance, IE (HIGH=90; AVG=60; LOW=10) [%]	
My Energy Costs and Equipment Efficiencies:	
Summertime cost of electricity (HIGH=0.20; AVG=0.10; LOW=0.05) [\$/KWh]	
Air conditioner efficiency (COP) over cooling season (HIGH=2.5; AVG=2.0; LOW=1.5)	
Energy source for heating (choose one)	○ Electricity ○ Fuel
If electricity, wintertime cost (HIGH=0.20; AVG=0.10; LOW=0.05) [\$/KWh]	
If fuel, cost (Natural gas: HIGH=1.00; AVG=0.70; LOW=0.50) [\$/Therm]	
(Fuel oil: 2002 East coast=0.85; 2002 Midwest=0.70) [\$/Therm]	
Heating system efficiency (Furnace or boiler: HIGH=0.8; AVG=0.7; LOW=0.5)	
(Electric heat pump: HIGH=2.0; AVG=1.5) (Electric resistance: 1.0)	
My Electricity Demand Charges and Duration:	
Demand charge during cooling season (HIGH=15.00; AVG=10.00; LOW=5.00) [\$/KW]	
Months charged for peak demand (Typical = 6) [-]	
Calculate My Annual Savings	
Total Annual Energy + Demand Savings (relative to a black roof) [\$/ft^{2} per year]	← Step 9 View savings
Cooling energy savings [\$/ft^{2} per year]	
Heating energy savings (heating penalty if negative) [\$/ft^{2} per year]	
Cooling season demand savings [\$/ft^{2} per year]	

DOE Cool Roof Calculator
http://web.ornl.gov/sci/buildings/tools/cool-roof/peak/
(Accessed October 2020)

Using the DOE Cool Roof Calculator

In addition, this total cost amount is broken down into three key cost components**.**

1. **Cooling energy savings**
   This amount includes total air conditioning savings from both base use and peak demand reductions.

2. **Heating energy savings/heating penalty**
   This amount includes any changes in overall heating costs due to the cool reflective roof. Essentially, this estimate helps to account for heating losses, if any, incurred in winter when solar radiation that could help heat the building is reflected back into the atmosphere.

3. **Cooling season demand savings**
   This is an estimate of the reduction in peak demand charges due to roof reflectivity. The amount shown is included in the cooling energy savings previously identified.

Using the DOE Cool Roof Calculator

It should be noted that the Cool Roof Calculator does not account for the potential for snow cover of the roof in the winter. The presence of accumulated snow on the roof surface may have two effects on overall energy savings. First, snow on either a cool or a dark roof surface will reduce the amount of solar energy absorbed into the building, which may increase heating costs. Conversely, a thick accumulation of snow may provide additional thermal insulation that may reduce heating costs.

All costs provided by the calculator are stated in dollars per square foot of roof area. As a result, these costs must be multiplied by the total square footage of roof surface area to estimate annual cost savings for the entire building.

The DOE Cool Roof Calculator is designed to compare the total roof-related net energy costs for a cool roof with a reflectivity as specified by the user to a black roof with a solar reflectance of 0.05 (5%). If the user wishes to compare two cool roofs with different reflective ratings, the user may run separate calculations on each roof and then manually compute the difference in savings between the two roofs.

Applying the Cool Roof Calculator

Now that we've reviewed the basic workings of the Cool Roof Calculator, we can examine in greater detail what the calculator may reveal about base use and peak demand savings across the U.S. and Canada.

Although it is difficult to accurately estimate exact base use and peak demand without a detailed examination of the construction and cost conditions for a specific building, it may be possible to develop a useful model by applying conservative assumptions suitable to a wide array of locations and buildings across North America.

In order to develop an informative portrait of peak demand and cool roofs throughout the U.S. and Canada, a model study for a typical cool roof versus a black roof using the following parameters applied to the Cool Roof Calculator was conducted.

Review Question

What is the explanation for the fact that peak demand savings are very similar across all U.S. climate zones?

Review Question

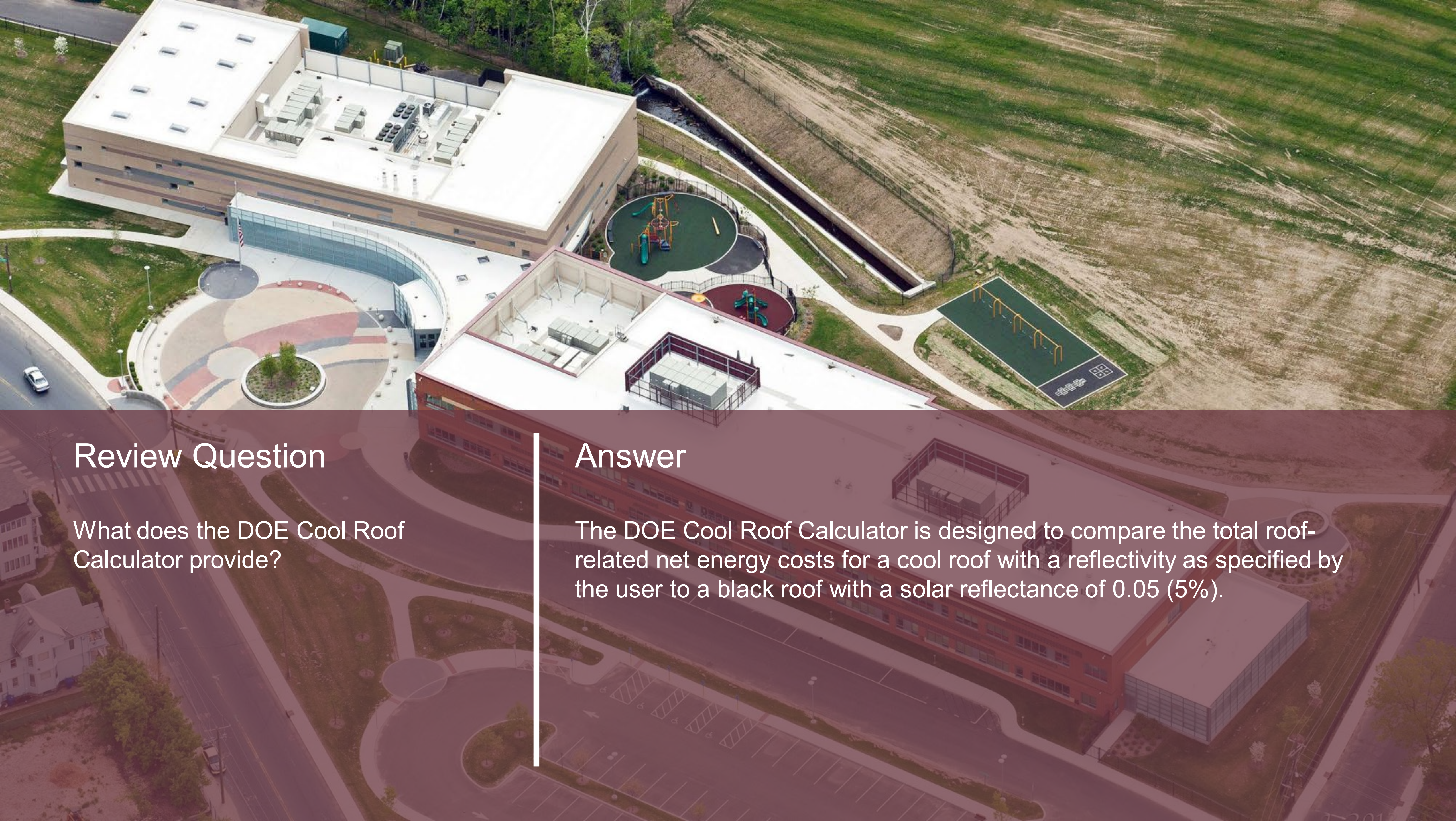
What is the explanation for the fact that peak demand savings are very similar across all U.S. climate zones?

Answer

In a hot location such as Phoenix, even though overall cooling loads are very high, the seasonal peak is less pronounced, while the seasonal peak in a cold location such as Minneapolis is much more pronounced even though the overall cooling loads are smaller. In effect, peak demand savings in hot climates may be described as a smaller piece of a larger pie, while peak demand savings in cold climates may be described as a larger piece of a smaller pie.

Review Question

What does the DOE Cool Roof Calculator provide?



Review Question

What does the DOE Cool Roof Calculator provide?

Answer

The DOE Cool Roof Calculator is designed to compare the total roof-related net energy costs for a cool roof with a reflectivity as specified by the user to a black roof with a solar reflectance of 0.05 (5%).

Cool Roof Model Study

Model Study Parameters

This section of the course provides a climatic analysis for a typical cool roof versus a black roof using the following parameters applied to the Cool Roof Calculator:

Climate zones and representative cities

- The *International Energy Conservation Code* (IECC) divides the United States and Canada into eight primary climate zones, with zone 1 as the warmest and zone 8 the coldest. Within each zone, demand for heating and air conditioning tends to fall within a relatively narrow range, allowing for a similar thermal analysis of buildings within the climate zone. A map of the eight climate zones in the United States and Canada and the model cities selected for this study will be reviewed in detail later.
- For the purposes of this study, the building was assumed to be a low-rise structure of one or two stories with a flat roof area of 20,000 square feet. In addition, it was assumed that the building was cooled with an electric air conditioning system with a coefficient of performance (COP) of 2.0 and heated with a natural gas-fired furnace with an efficiency rating of 70%.

Model Study Parameters

Roof insulation (R-value) level

- Two insulation conditions were selected for the analysis to allow for a comparison of different roofing scenarios. The "new insulation" condition assumes that the existing roof is completely removed and replaced with a new roofing system using R-value levels meeting the latest energy code requirements. The "old insulation" condition assumes that the existing roof and insulation remains in place and is simply re-covered with a new roofing membrane with no additional R-value. The new insulation condition is intended to model the installation of a completely new roof on an existing building or a newly constructed building, while the old insulation condition is intended to model the installation of a roof re-covery over an existing roof that remains in place. These old and new insulation levels are summarized in a later slide in this presentation.

Model Study Parameters

Roof reflectance/emittance

- The long-term reflectance of most cool roofs tends to fall within a relatively narrow range, specifically from 0.55 to 0.63 for minimum aged reflectance as shown previously in this presentation. Accordingly, the cool roof modeled in the analysis is based on a reflectance of 0.60, which falls approximately midrange of these aged values. And because the Cool Roof Calculator automatically compares this cool roof to a black roof with a reflectance of 0.05 and an emittance of 0.90, an emittance value of 0.90 also was selected for the cool roof.

Base use and peak demand charges

- Because the example electric bill from the state of Indiana shown earlier represents one of the lower rates available in North America, a comparison based on those rates obviously should provide a conservative estimate. As a result, this model study assumes a base use rate of $0.033/kWh and a peak demand charge of $20.10/kW across all eight major climate zones. In addition, the analysis assumes a rate of $0.70/therm for natural gas, which is very close to the average commercial rate across North America at this time.

Summary of Model Study Parameters

- Composite of model cities in each North American climate zone

- Representative commercial building
  - 20,000-square-foot low-rise structure
  - Heated and cooled with typical HVAC equipment (AC COP = 2.0, Furnace Efficiency = 0.70)

- Two construction conditions/insulation levels
  - “New insulation” meeting 2012 IECC insulation levels
  - “Old insulation” meeting pre-2012 IECC levels

- Cool roof solar reflectance (SR) = 0.60 and thermal emittance (TE) = 0.90
  - Solar reflectance (SR) = 0.60
  - Thermal emittance (TE) = 0.90
  - Compared to black roof with SR = 0.05 and TE = 0.90

- Electrical base use and demand charge identical to sample energy bill
  - Base use: $0.033/kWh
  - Demand charge: $20.10/kW
  - Plus natural gas for heating at $0.70/therm

Climate Zones and Selected Cities

Here is a map of the eight major climate zones (as defined by the IECC) in North America, as well as a listing of model cities used for the analysis in each climate zone. In the case of the most extreme zones, only one city was selected since the zones are either small or sparsely populated. However, in the intermediate climate zones, two cities were selected and their climate data averaged to provide a more accurate representation for all cities within the zone.

Climate Zone	Model Cities
1	Miami
2	Houston, Phoenix
3	Atlanta, Dallas
4	St. Louis, Baltimore
5	Chicago, Pittsburgh
6	Milwaukee, Minneapolis
7-8	Duluth

Source: Center for Environmental Innovation in Roofing and the Polyisocyanurate Insulation Manufacturers Association

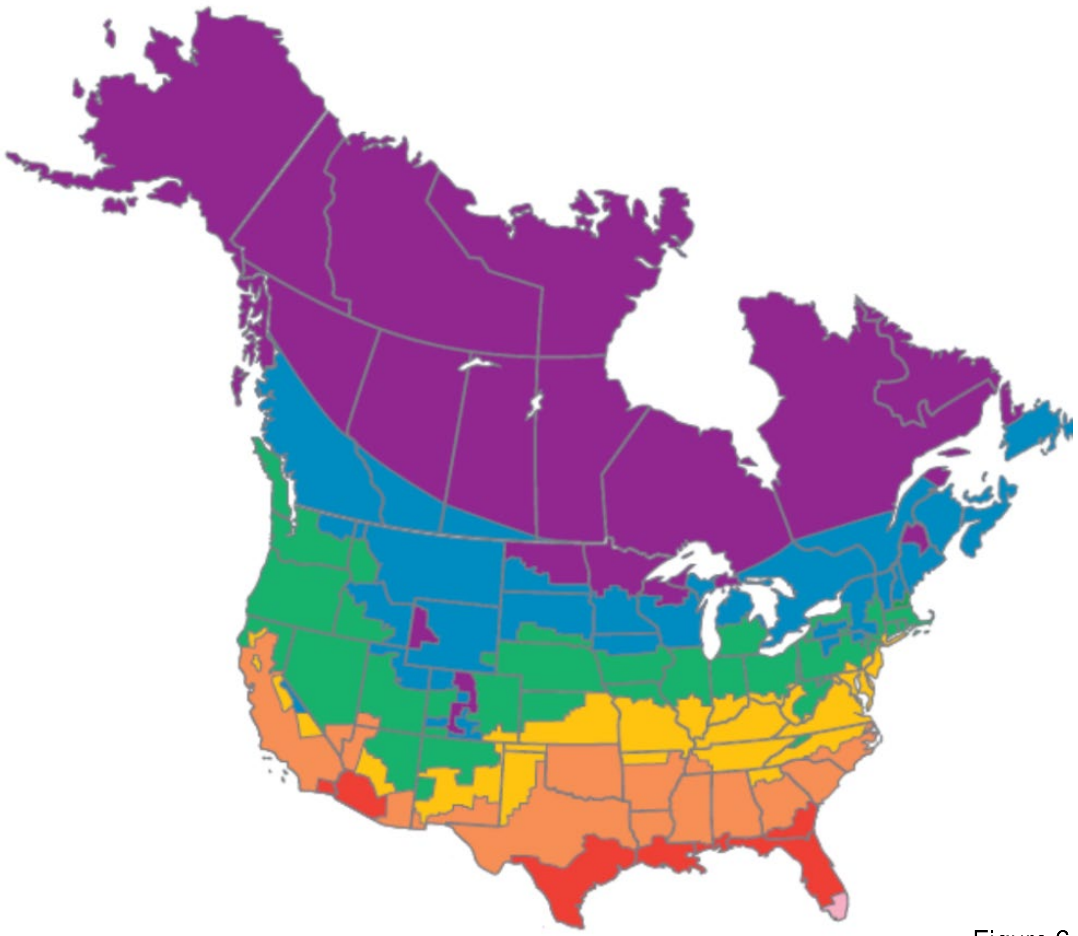


Figure 6

Climate Zones and R-Values

Because the amount of roof insulation used in buildings varies according to climate zone, lower levels of insulation were assumed for the warmer climates and higher levels were assumed for colder climates. In addition, because code-mandated insulation levels have increased over the past decade, different insulation levels were applied to the old and new insulation conditions. For the old insulation condition, R-value levels were based on an earlier (2006) version of the *International Energy Conservation Code*, and for the new insulation condition, R-value levels were based on the 2012 edition of the code.

Climate Zones and R-Values

This table provides a summary of the R-values used in the study for each climate zone, both for the new and the old insulation conditions. As shown in the table, the R-value ranged from a low of R-10 for the old insulation condition in the warmest climate zone to a high of R-35 for the new insulation condition in the coldest climate zone.

Climate Zone	Roof R-Value	
	Old Insulation Condition[1]	New Insulation Condition[2]
1	10	20
2	15	20
3	15	20
4	15	25
5	15	25
6	15	30
7–8	15	35

Notes:
1. Per 2006 *International Energy Conservation Code*
2. Per 2012 *International Energy Conservation Code*

Calculations

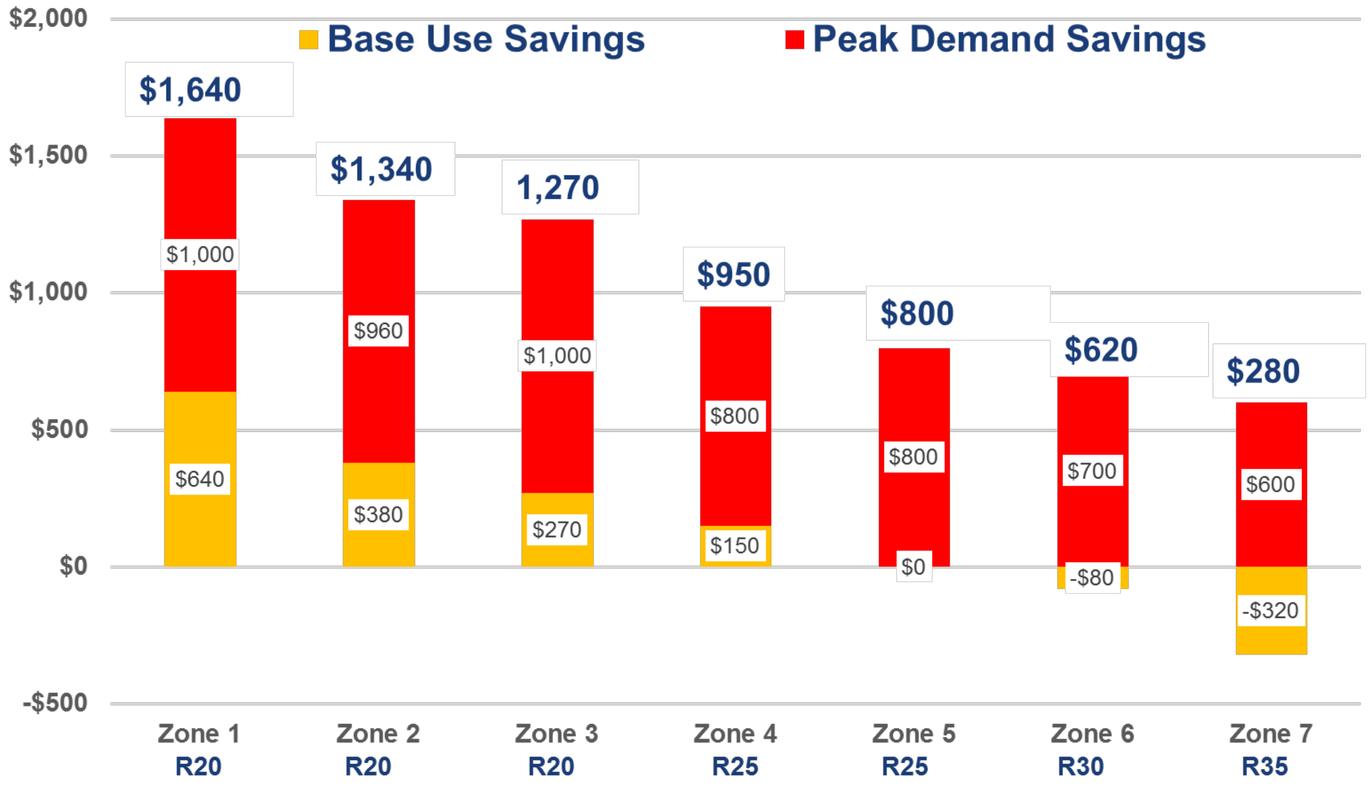
Using the assumptions and values stated, estimated base use and peak demand savings for a typical 20,000-square-foot commercial building in all eight climate zones were calculated using the DOE Cool Roof Calculator.

For each climate zone, two different roof conditions were examined.

- The first set of calculations compared a cool roof against a black roof installed over new roof insulation meeting the most recent energy code R-value requirements.
- The second set of calculations compared the same cool and black roofs installed over existing (old) roof insulation meeting an earlier version of the energy code.

First Set of Calculations: New Insulation Results

This chart shows the results from the first set of calculations, which compared a cool roof against a black roof installed over new roof insulation meeting the most recent energy code R-value requirements.



Estimated Net Energy Savings: Cool Roof Installed over New Insulation
(Annual Dollars / 20,000 Square Foot Roof Area)

First Set of Calculations: New Insulation Results

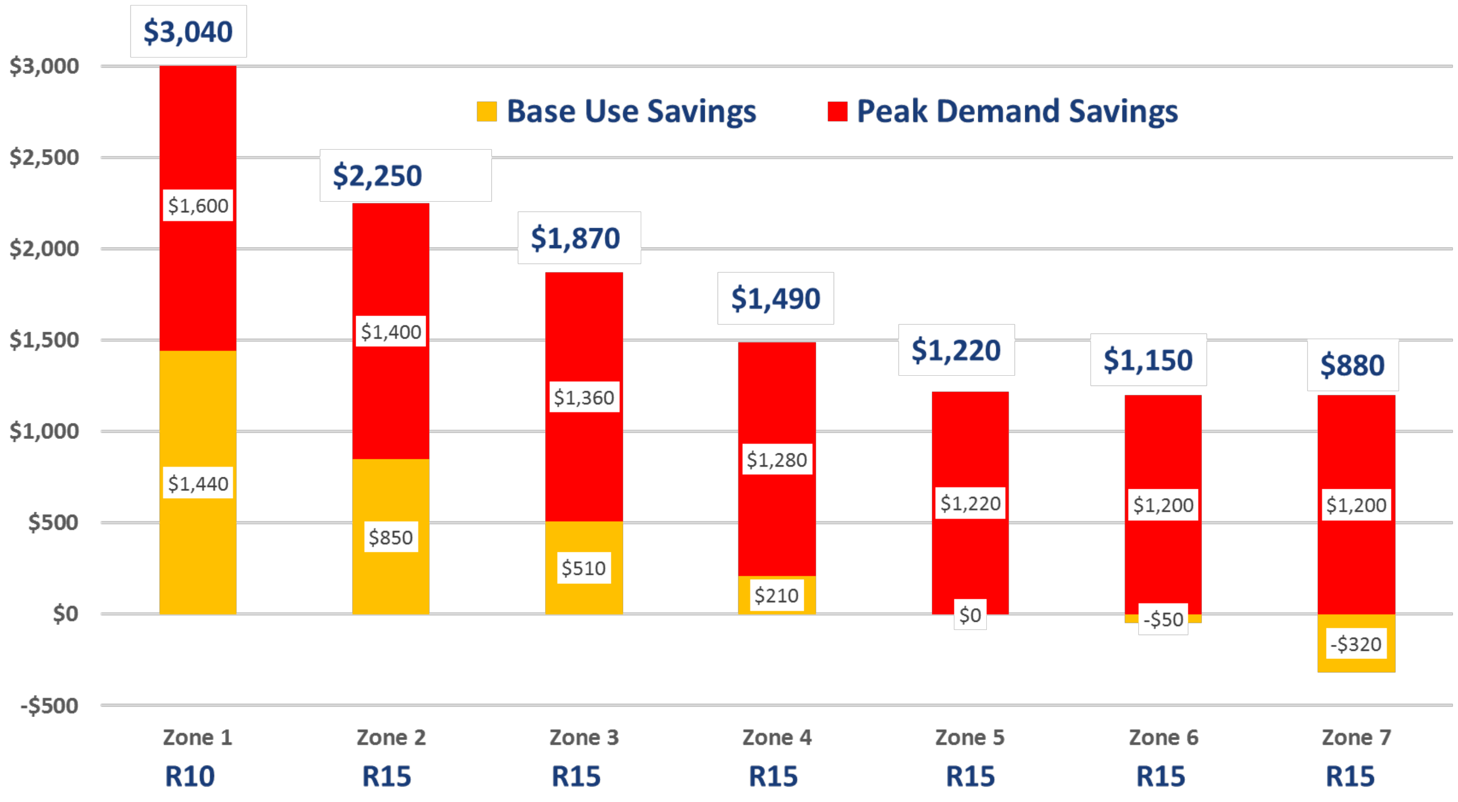
In the case of the new insulation condition, estimated base use savings ranged from a negative $320 in climate zone 7 to a positive $640 in climate zone 1. It is interesting to note that these estimates of positive and negative savings are very similar to the results from other studies that looked at either base or net average savings for cool roofs.

However, for the new insulation condition, the estimated peak demand savings are significantly higher and positive throughout all climate zones, ranging from a low of $600 in zone 7 to a high of $1,000 in zone 1.

And when both base and peak estimated savings are added together, the total estimated annual savings for the cool roof varied from a low of $280 in zone 7 to a high of $1,640 in zone 1.

Second Set of Calculations: Old Insulation Results

This chart shows the results from the second set of calculations, which compared a cool roof against a black roof installed over old roof insulation meeting the earlier (2006) energy code R-value requirements.



Estimated Net Energy Savings: Cool Roof Installed over Old Insulation

(Annual Dollars / 20,000 Square Foot Roof Area)

Second Set of Calculations: Old Insulation Results

In the case of the old insulation condition, estimated base use savings ranged from a negative $320 in climate zone 7 to a positive $1,440 in climate zone 1. Again, it is interesting to note that these estimates of positive and negative savings are very similar to the results from other studies that looked at either base or net average savings for cool roofs.

However, for the old insulation condition, the estimated peak demand savings are significantly higher and positive throughout all climate zones, ranging from a low of $1,200 in zone 7 to a high of $1,600 in zone 1.

And when both base and peak estimated savings are added together, the total estimated annual savings for the cool roof varied from a low of $880 in zone 7 to a high of $3,040 in zone 1.

The Bottom Line: Cool Roofs and Peak Energy Demand

Savings in all climates and conditions

- As illustrated in the previous two charts, the total value of base plus peak energy savings offered by the cool roof is sizeable, averaging more than $1,000 annually in most climate zones for a typical commercial building. In addition, these savings appear to be equally important for buildings with either old or new levels of insulation. As a consequence, cool roofs may offer a significant opportunity for net energy savings even at the highest levels of roof insulation mandated by the latest building codes. The savings value of cool roofs is further reinforced because modern cool roofing membranes frequently cost no more than darker, noncool roofs. As a result, all the savings identified in the study tend to drop to the bottom line without any additional cost encumbrances.

The Bottom Line: Cool Roofs and Peak Energy Demand

Cool roofs and insulation level

- Differences in the level of new versus old insulation appear to have a significant effect on the amount of base use savings. In most cases, base use savings using the lower R-value levels of old insulation are reduced by half or more by the addition of the higher R-value levels of new insulation. However, this condition does not appear to hold for peak demand savings. In most cases, the savings available using either old or new insulation levels appear to be significant for all climate zones. **Therefore, it appears that significant reductions in peak demand cost cannot be achieved simply by increasing insulation levels without also installing a cool roof covering.**

The Bottom Line: Cool Roofs and Peak Energy Demand

Peak demand reduction drives the savings

- One of the most striking results from this study is that the estimated savings due to peak energy demand reduction provide a substantial majority of the net energy savings throughout all climate zones studied. In fact, peak demand savings account for over 50% of total savings in the warmest climate zones and up to 100% in the coldest climate zones. Moreover, while base use savings tend to vary widely by climate zone (even falling to negative values in the coldest climates), peak demand savings tend to be more significant and consistent throughout all climate zones. As a consequence, the study clearly suggests that any estimate of cool roof savings that neglects to include peak demand reduction has little chance of providing an accurate estimate.

Effect of fuel selection on net energy savings

- Natural gas forced air was selected as the heating system in these calculations. If electric resistance heat or an electric heat pump were selected, the base use savings would decrease slightly due to a higher winter heating penalty applied to the electric heating system. If an oil-fired furnace were selected, the base use savings would increase slightly due to the higher cost of heating oil compared to natural gas. However, the peak demand savings would remain the same regardless of the heating system and fuel source selected.

Key Takeaways and Next Steps

Key Takeaways and Next Steps

Here are the key takeaways from the information provided in this course.

Know your clients' electrical bills

- Since electrical bills tend to be a little complicated, it's difficult to go to a list of charges posted on a state or federal database to ensure you have everything covered. Just like the sample bill shown in this presentation, base and peak charges may be applied to an ever-expanding number of tariffs, and it is necessary to add up the results of each line item in order to discover the actual base and peak demand rate being paid by your client. Avoid using a nominal "average" utility rate that may be found in a national database. As shown in the example bill in this presentation, the nominal base rate of $0.033/kWh quickly can become an actual average rate of twice or more that amount after demand charges are factored in.
- Also, if you discover that your client isn't paying peak demand charges at this time, it might be worth recommending that the client discuss a new rate plan that does include demand charges. In many cases, rates that do not include the accommodation of demand charges to the utility may turn out to be higher in the net, and such rates will never allow your client the opportunity to take advantage of all the ways peak demand can be reduced to save money.

Key Takeaways and Next Steps

Use the DOE Cool Roof Calculator

- The DOE Cool Roof Calculator is free to use and comes with links to additional energy information that can help you make the best design decisions for any situation. And in any case, avoid the use of energy calculators that fail to take peak demand charges into consideration.

Use the calculation results

- Use the calculated results generated by the DOE Cool Roof Calculator to shape your design decisions. You will be able to demonstrate greater value for a roof design by leveraging the potential savings available via peak demand reduction.

Remember

- There are potential savings available in all climates and conditions studied for climate zones 1 through 8. This applies to new roofs or roof re-covers and with all levels of roof insulation.
- Peak demand reduction drives the potential savings with over 50% in all climate zones and up to 100% in the coolest climate zones.

Resources

Resources

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- For more information on Cool Roof Rating Council rated roofing products, please visit http://coolroofs.org/products/results. Accessed October 2020.

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Conclusion

Thank you

This concludes The American Institute of Architects Continuing Education Systems Course.