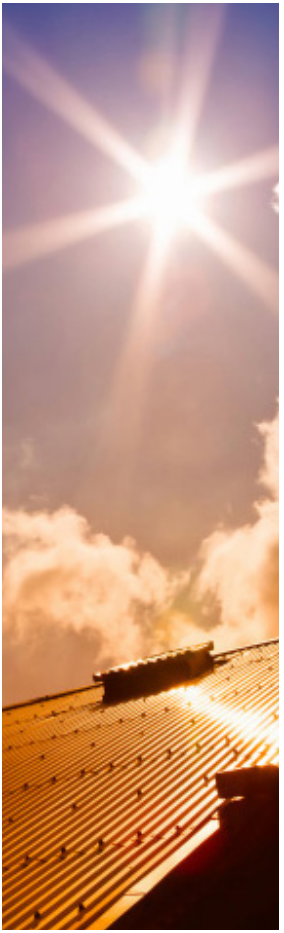
Institute for Catastrophic Loss Reduction
Building resilient communities

Focus on

Extreme heat

Designed for safer living® *is a program endorsed by Canada's insurers to promote disaster-resilient homes.*



About the Institute for Catastrophic Loss Reduction

The Institute for Catastrophic Loss Reduction (ICLR), established in 1997, is a world-class centre for multidisciplinary disaster prevention research and communication. ICLR is an independent, not-for-profit research institute founded by the insurance industry and affiliated with Western University.

The Institute's mission is to *reduce the loss of life and property caused by severe weather and earthquakes through the identification and support of sustained actions that improve society's capacity to adapt to, anticipate, mitigate, withstand and recover from natural disasters.*

ICLR's mandate is to confront the alarming increase in disaster losses caused by natural hazards and to work to reduce disaster deaths, injuries and property damage. Disaster damage has been doubling every five to seven years since the 1960s, an alarming trend. The greatest tragedy is that many disaster losses are preventable. ICLR is committed to the development and communication of disaster prevention knowledge. For the individual homeowner, this translates into the identification of natural hazards that threaten them and their home. The Institute further informs individual homeowners about steps that can be taken to better protect their family and their home.

The purpose of this handbook is to outline actions that homeowners can take to protect their homes and, as a result, themselves, from extreme heat. Some of these measures are simple and free; others cost money. All contribute to reducing the impact of extreme heat.

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Cover photos: (top) Wikimedia; (bottom left) PYC Awnings, Pennsylvania; (bottom right) HomeGuard Restoration

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- any personal injury or bodily injury, including death, and any loss or damage caused by extreme heat to insured or uninsured structures and/or property as a result of actions outlined in this document.

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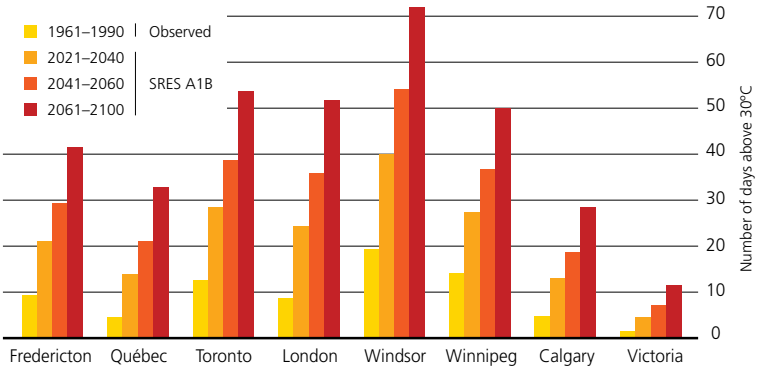
Extreme heat

In many parts of the country, Canadians are experiencing more frequent and extreme heat events. Temperatures sometimes soar to levels that are dangerous to health and safety. The risk of health impacts from extreme heat is expected to continue rising due to climate change.

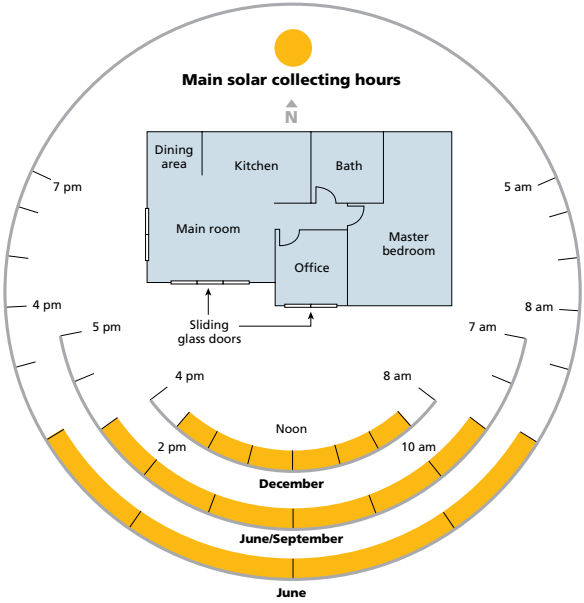
The evidence over the past 20 or 30 years shows that the risk of death or serious health issues increases when the temperature rises. In particular, fatalities in many urban centres across Canada often start to increase when the temperature is above 25°C, and increase significantly when the temperature is above 35°C. Some communities have even experienced a few days when the temperature has exceeded 40°C. Over the next 25 years, it is likely that many – perhaps most – Canadians will experience high temperatures dangerous to their health.

Current and projected number of days exceeding 30°C/86°F for Canadian cities

The number of hot days for each city is based on the observed temperature data between 1961 and 1990, and projected for 2021–2040, 2041–2060 and 2081–2100.



Source: Developed by Kharin Slava, Canadian Centre for Climate Modeling and Analysis, Canadian Global Climate Change Model version 3.1, personal communication, 2009.



Interior layout

Good interior layout can assist greatly with passive heating and cooling, with particular opportunities for efficient daylighting.

Synergies/Barriers:

Layout decisions should incorporate other building elements and work in harmony with them, such as the windows and mechanical systems.

Impact on Energy Efficiency:

Good interior layout can off-set later energy consumption by reducing need for light and heat.

The risk of heat illness and death is greatest for older adults, infants, young children, people with chronic illnesses, those who are physically disabled, and people living alone. The risk is greatest when temperatures increase beyond rates traditionally experienced, and when these high temperatures are sustained through several consecutive extraordinarily warm days and nights.

Fortunately, there are actions that can be taken to ensure that new homes are designed, and existing homes are retrofitted, to protect those who reside in them from extreme heat.

This publication is designed to assist homeowners whose residences are at risk of extreme heat. Recommendations presented here to reduce overheating of low-rise residential structures include elements around building design, considerations for building materials, and landscaping approaches.

The information to follow provides an overview of key areas in and around the house and lot that may require attention in order to reduce the risk posed by extreme heat to a home and – hence – to its occupants. Several measures presented in this document, while focused on management of heat-related impacts, have additional benefits related to energy efficiency.

First steps

Understand your home's vulnerabilities

Unlike other natural hazards, like extreme wind or rain for example, extreme heat does not do extensive damage to homes per se. The idea of protecting a home from extreme heat is ultimately to protect the home's residents from the negative impacts of overheating. It is important to be aware and educated about your home's vulnerabilities to the threat of extreme heat and other hazards.

1 Talk to your local government

Local governments may be able to offer important advice for homeowners on how to protect their home from extreme heat. Municipal government websites, public works, utilities and the building department can all be useful sources. Towns and cities located in parts of the country with hotter summers may be able offer more information on how to protect your home. Considerations include:

- What advice do they offer?
- What does your local government suggest you do?
- Do they offer incentives, or are they familiar with incentives offered by other levels of government for such things as energy efficient windows or improving insulation?
- Do they recommend contractors with expertise in protection from extreme heat?
- Are there any by-laws which may prevent you from taking certain actions?
- What permits, if any, are required to strengthen your home's defenses?

2 Have a private building inspector evaluate your home

Because every home is different, private building inspectors may be able to offer important insights into the your home's capacity to withstand extreme heat and other hazards.

Taking action on your own or with help from contractors

These initiatives cannot guarantee personal safety and the security of any property but, if properly addressed, will help to minimize the risk of extreme heat damage to your home and, thus, harm to residents. It is recognized that homeowners may be able to perform none, some, most or all of the items in this section, or may choose to utilize third-party contractors.

Landscaping

Landscaping choices, essentially using shading trees and other plants near south, east and west-facing exposures, will work to minimize solar heat gains through windows.

It is recommended that deciduous trees (i.e. leafy green trees that shed leaves seasonally, as opposed to needled coniferous trees that do not shed) be planted to provide shading for south, west and east-facing windows. Deciduous trees provide shade in the summer and early autumn, but allow for sun to heat the home in the colder months when they have shed their leaves.

Landscaping with coniferous trees or hedges can help provide a windbreak or filter against harsh winds, particularly in winter.

At least 25 per cent of the lot surface (less roof area) should be comprised of tree cover.

For those living in areas of the country that present risk of wildfire to structures, it is essential that landscaping comply with FireSmart® landscaping guidelines and should not increase risk of wildland urban interface fire. Information on FireSmart® and FireSmart® landscaping information can be found at **www.firesmartcanada.ca**.

Trees should also be properly maintained and trimmed to prevent power outages and damage during windstorms.

What is a U-Value?

U-Value is the amount of heat loss or gain through a construction material. U-value is measured by U = I/R. U-values for windows can refer to the centre of glass or edge of window whole frame' measurements. The value will change with the size of the window because the ratio of window to frame will increase as the window gets bigger. Most manufacturers provide the U value of the glass and the frame separately – proper analysis must assess the U value of the entire system.

Windows

According to the City of Vancouver, residential buildings can lose about half of their heat through windows but gain only a few percentage points back in passive solar gain. "In order to design windows that contribute to passive heating in the cooler winter months without an associated overheating risk in the summer, it is critical to balance location, size and thermal quality."

The City maintains that there are four major considerations when choosing windows that minimize heat loss and maximize solar gains in colder months:

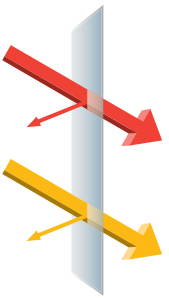
- How does window design address daylighting, views, ventilation?
- How much heat loss will be attributable to the windows?
- What is the payback for investing in high performance systems?
- Are there other design considerations (overhangs, landscaping etc.)?

Overall window quality is an important consideration. This includes the solar heat gain coefficient of the glass and spacer material. Other considerations here include number of panes (double versus triple) and the material used for frames.

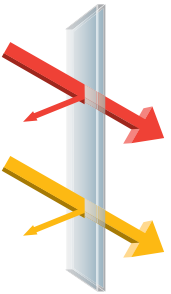
When replacing windows (and doors) for an existing home or purchasing windows for a new build, products should be selected that have low U-Values (a.k.a. thermal transmittance, the rate of transfer of heat through a structure divided by the difference in temperature across that structure).

Heat gain/loss

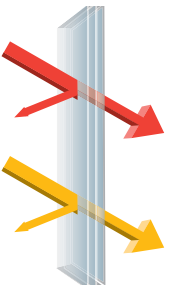
(Adapted from *Passive Design Toolkit for Homes, City of Vancouver*)



Single pane U-Factor = 1.04



Double pane U-Factor = 0.50



Triple pane U-Factor = 0.15

Windows and doors should also have a low minimum air leakage value.

According to Vancouver, style of window is also key to balancing the issue of heat loss and solar gain: "Slider windows may be poorer air barriers as the sealing system is harder to design. Fixed windows are permanently sealed but do not offer the benefits of ventilation. Hinged windows use compression seals that are more sturdy than slider windows but may still wear out. Issues arise when worn out seals are not replaced."

It should be noted that homes built to reduce the impact of extreme heat typically use windows that swing inward, which gives a better seal.

Positioning of windows according to exposures is also important. According to Vancouver, window area on south elevations should be maximized, while east-facing elevations should be limited in size or protected by overhangs or trees and west elevations should be avoided unless they can be fully shaded during the summer.

As a general rule of thumb, windows should not exceed ⅔ of the envelope. Further, the number of windows used should be kept at a minimum. Vancouver notes that "one slightly larger window is more efficient than two windows even if they equal the same area of window."

Homeowners are advised to consult with window experts on how best to meet these requirements for their homes.

Detailed information on windows, including performance comparisons and placement recommendations, can be found in the City of Vancouver's *Passive Design Toolkit for Homes*.

Window shading

As with the strategic planting of trees, shading windows through the use of structure design or commercially available window shading devices or products can also work to reduce solar heat gains through windows. Homeowners are advised against relying only on curtains or interior blinds, because the idea is to reduce heat from the sun before it enters the home.

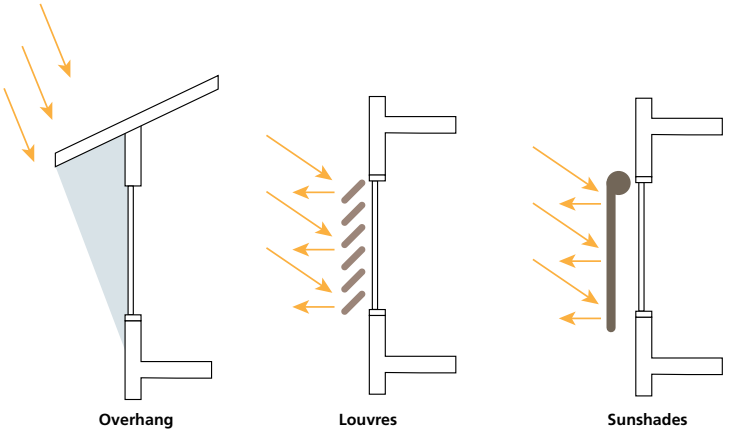
Common strategies used for window shading: (top left) covered porches; (top right) insulated exterior roll shutters; (bottom left) vertical or horizontal louvres; (bottom right) exterior screens

From a building design standpoint, windows and glass doors can be shaded with permanent design elements, like covered porches, brise-soleils and vertical or horizontal louvres.

Products that can be used to shade windows (some of which are less permanent than design elements) may include insulated exterior roll shutters, exterior window screens, roll out awnings and heat control window films. It should be noted that such options as roll shutters and roll out awnings require the homeowner to physically operate them, while other options are more passive.

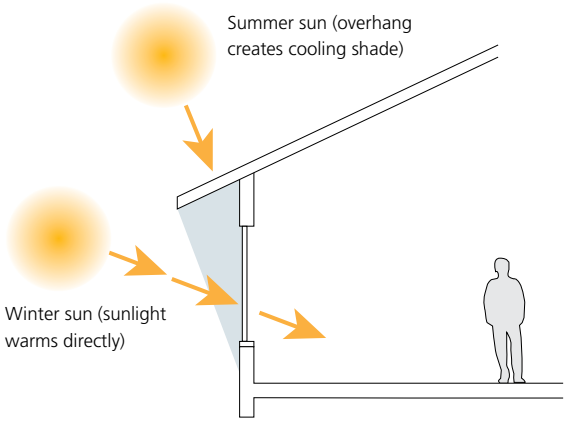
Passive window shading

(Adapted from *Passive Design Toolkit for Homes, City of Vancouver*)



Overhang

Because the winter sun is at a lower angle, sun can travel directly into the building warming it during the cool months. The high summer sun is blocked by the overhang creating a cooling shade



Lighting

Availability of natural lighting is important, as access to high quality natural light reduces the need for artificial lighting, keeping interior temperatures down and reducing energy bills.

Building layout and orientation are key considerations and, again, success depends on the right balance between gaining access to natural light while reducing solar gains. South-facing exposures, for instance, will provide a lot of quality sunlight, but will also provide for high solar gains. North-facing exposures, conversely, will deliver good quantities of diffused sunlight, with low solar gains. Designs should seek to balance different lighting needs according to the room (direct light for kitchens, offices, workshops etc., diffused light for living rooms and bedrooms). It is recommended that all living areas (kitchen, living rooms, dining rooms) be located on the south exposure and bedrooms on the north.

Other considerations include the type of light source used for artificial lighting. Standard incandescent bulbs are inefficient as light sources and they omit high amounts of heat. Energy efficient bulbs should be used where possible. Homeowners may also consider using lighter colour paints on walls, windowsills etc. Lighter colours reflect more light than do darker surfaces.

Roofing

When replacing older roof covering or choosing covering for an addition or new build, homeowners might consider installing a cool roof.

According to the U.S. Department of Energy "A cool roof is one that has been designed to reflect more sunlight and absorb less heat than a standard roof. Cool roofs can be made of a highly reflective type of paint, a sheet covering, or highly reflective tiles or shingles."

Cool roofs can serve to reduce reliance on air conditioning systems, improve thermal comfort for indoor spaces, reduce local air temperatures and provide other additional temperature and energy-related benefits.

Example of a cool roof, Rosemont-Petite-Patrie, Montreal

Cool roofs can come in many forms and much depends on whether the roof is low-sloped or steep-sloped. Green roofs, which can include anything from basic plant cover to a garden, are also considered a form of cool roof.

Homeowners will best be served by discussing cool roof options with their roofing expert or contractor. They may also wish to discuss any plans to install a green roof with their insurance provider before installation takes place.

Insulation

Insulation in a home generally serves two purposes: 1) It mitigates heat loss or gain and 2) It lessens or even eliminates radiant energy from hot surfaces in warm months (e.g. asphalt shingled roofs) and cold surfaces in winter (e.g. exterior walls).

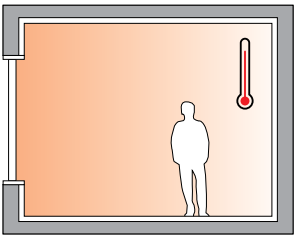
Victoriaville, Quebec

The City of Victoriaville, QC, designed and implemented a program that incentivizes the introduction of sustainability and resiliency features into the construction of new homes and the renovation of existing homes. Some measures suggested provide improved thermal comfort, include tips on tree planting around properties and the promotion of cool roofs.

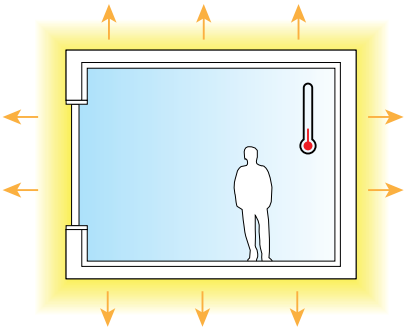
Heat exits a non-insulated building quickly thus requiring more heating resources to keep a room comfortable

(Adapted from *Passive Design Toolkit for Homes, City of Vancouver*)

Insulated



Not insulated



According to the City of Vancouver, "Insulation is arguably the most critical determinant of energy savings and interior thermal comfort, though good insulation should not preclude consideration of air tightness, heat bridges and appropriate windows."

The City recommends that these questions be asked when a homeowner is making decisions regarding replacing or reinforcing insulation in an existing property, or when planning for a new build:

- What is climate-appropriate insulation for this building?
- What are the environmental considerations of the material selected?
- Are there other benefits of the material besides insulation?
- How will the design of the building be airtight?

When making decisions regarding insulation, homeowners – and contractors – should also be aware of minimum insulation requirements of the respective provincial building code and ensure that these requirements are met, at the very minimum. Considerations must be made for roofs with and without attics, above grade and below grade (i.e. foundation) walls, and slabs where there is no basement.

Detailed information on the different types of insulation and their pros and cons can be found in the City of Vancouver's *Passive Design Toolkit for Homes*.

Design strategies and structural improvements to your home

Passive design strategies

Passive design, climate adaptation design, or climate responsive design are defined as approaches to building design that use "…the building architecture to minimize energy consumption and improve thermal comfort" (City of Vancouver Passive Design Toolkit).

Proposed building code changes that relate to heat adaptation in new homes include lower U-value windows, air tightness testing, and continuous insulation.

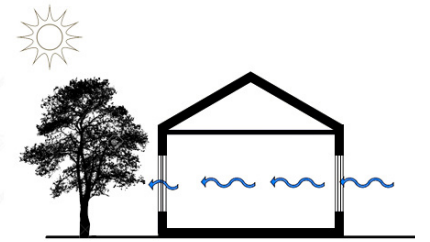
New construction offers an opportunity for increasing the stock of heat resilient homes. Buildings that are designed to promote passive cooling and higher levels of thermal comfort are more likely to keep cool during summer power outages and extreme heat events, thereby reducing the risk of morbidity and mortality.

Recommendations presented here for reducing overheating of low-rise residential structures include building design, building materials, and landscaping approaches. While most of these measures can be implemented in both new and existing homes, passive cooling and thermal comfort is optimized when measures are integrated early in the design process of a building.

Design strategies for passive cooling

Passive cooling design optimizes a house's orientation, shape, glazing, and placement of glazing to limit overheating during heat waves and power outages. Decisions regarding the placement and size of windows can make houses more resilient towards extreme heat by both influencing the amount of glazing that is exposed to the sun, and promoting cross-ventilation inside the building (see example). Placing windows on opposite sides and at different heights of the building promotes the flow of air through the building.

Example of cross-ventilation



Montreal, Quebec

In Montreal, the borough of Rosemont-La Petite-Patrie decided to revise its zoning by-law to mandate property owners that were replacing or building a new roof to install a green (vegetative) roof, a white roof, a highly reflective roof, or a combination of these different types. This initiative was implemented in an effort to mitigate the urban heat island effect in the City and has since been adopted by several other boroughs across the City.

Materials used in new home construction can also affect passive cooling. For example, double or triple glazed windows with low U-values, insulation in walls and roofs with higher R-values, and light or solar reflective building exteriors reduce risk of overheating and serve to reduce energy use. Reflective building exteriors may also help to reduce local urban heat island (UHI) effects.

Considerations when purchasing an existing house or planning for new home construction

Neighbourhoods/subdivisions and individual houses with the following features can reduce health risks associated with extreme heat:

- Gridded street patterns with longer blocks along the east/west axis allow for more homes to face north or south and have neighbouring homes shade east and west exposures;
- Streets, open spaces and buildings can be planned in a manner that promotes radial ventilation;
- Wide roads with vegetated shoulders and medians and open linear parks of 100m or more in width can increase urban cooling during summer nights;
- Compact buildings in densely planned subdivisions are beneficial. For instance, buildings can benefit from shared shade (i.e. where buildings are situated in a manner that allows them to shade each other. Compact buildings also have fewer external walls that are exposed to the elements, minimizing heat gain/loss potential;
- Open floor plans in individual homes promote both cross ventilation and energy efficiency;
- Simple floor plans (square/rectangular), with few corners and joints that tend to leak energy, are more efficient than complex floorplans;

Example of a green roof

- Kitchens should be located so as to avoid overheating (e.g. on the eastern and not western side of the building). Living spaces that are used predominately in the evening should be located on the western side of the building to take advantage of the evening sun. Bedrooms generally require less heat and can be located according to preference. Bedroom window size should be kept to a minimum and provide for the option of passive ventilation;
- Overhangs, like eaves, can help to minimize heat gain/loss, particularly for poorly oriented buildings that receive a great deal of direct sunlight on south, east and west exposures;
- In order to maximize the benefits of direct sunlight in winter, the longest elevation of the building should be oriented towards the south;
- To minimize unwanted solar gain in the summer, designs should minimize window or wall area oriented east or west. East or west-facing windows should be limited in size and should be protected by overhangs or trees;
- A minimum 25 per cent cover by vegetation should be maintained on the property (excluding roof area) and, where possible, existing trees should be preserved before and during construction.

ICLR would like to acknowledge Lintack Architects Incorporated for assistance in reviewing this publication.

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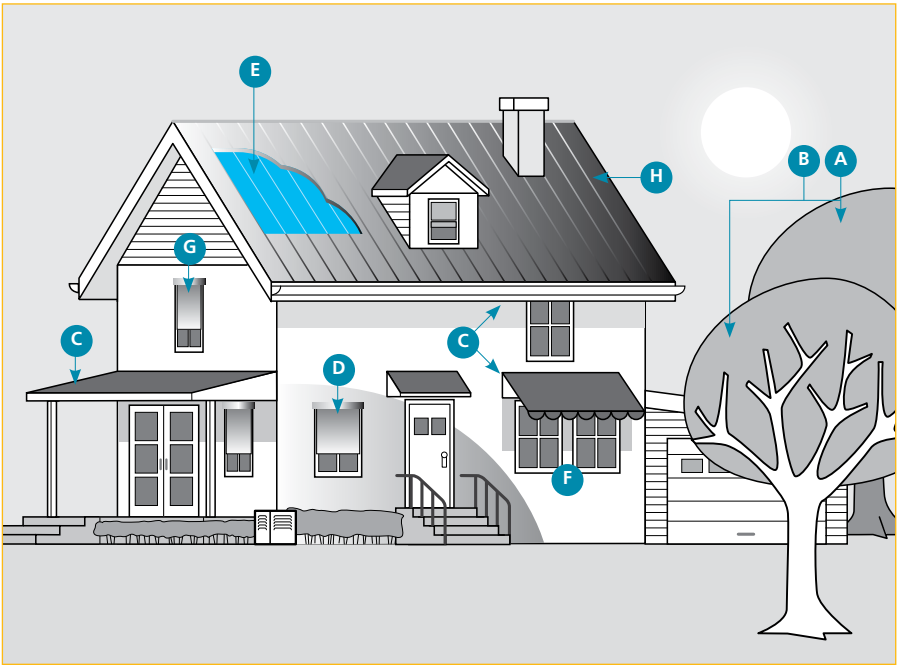
Protecting your home from extreme heat



A Leafy (deciduous) shade trees and other vegetation should be planted near windows, particularly on south, east and west-facing exposures.

B A minimum 25 per cent tree cover should be maintained on the property (excluding roof area).

C Windows and glass doors can be shaded with permanent design elements, like covered porches, awnings, brise-soleils, roof overhangs, and/or vertical or horizontal louvres.

D Products that can be used to shade windows may include insulated exterior roll shutters, exterior window screens, roll out awnings and heat control window films.

E Roofs (with or without attics), above and below grade (i.e. foundation) walls and slabs should be properly insulated.

F Good quality, energy efficient windows (double or, better, triple-paned) with low U-Values should be installed.

G The number of windows used should be kept at a minimum and should be small, particularly on exposure sides (south, east and west).

H When replacing older roof covering or choosing covering for an addition or new build, homeowners might consider installing a cool roof.

Important contact information

Insurance company

Address | Postal code

Telephone | Alternative telephone

E-mail | Website

Contact person | Contact person

Insurance broker or agent

Address | Postal code

Telephone | Alternative telephone

E-mail | Website

Contact person | Contact person

Municipal government

Address | Postal code

Telephone | Alternative telephone

E-mail | Website

Contact person | Contact person

Contractor

Address | Postal code

Telephone | Alternative telephone

E-mail | Website

Contact person | Contact person

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