

# Climate Resilient Buildings & Infrastructure: Resources for PSOs

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Note: resources preceded with an asterisk (\*) are recommended as introductory material.

## General Information about Climate Change and its Impacts

Warren, F.J. and Lemmen, D.S., (editors), 2014. *Canada in a Changing Climate: Sector Perspectives on Impacts and Adaptation*. Government of Canada, Ottawa, ON, 286p. See in particular sections on health and infrastructure. Available at

<http://www.nrcan.gc.ca/environment/resources/publications/impacts-adaptation/reports/assessments/2014/16309>.

## Climate Resilience in Buildings: Retrofit and New Build Options

Gething, B., 2010. *Design for future climate: Opportunities for adaptation in the built environment*.

Produced for the Technology Strategy Board. This report, written for readers in the construction industry, describes ways to design buildings that are resilient to climate change – in particular designing for thermal comfort, structural stability, weatherproofing, and managing water. Available at:

[http://www.arcc-network.org.uk/wp-content/D4FC/01\\_Design-for-Future-Climate-Bill-Gething-report.pdf](http://www.arcc-network.org.uk/wp-content/D4FC/01_Design-for-Future-Climate-Bill-Gething-report.pdf). (Note this is a large file that is slow to download.)

Institute for Catastrophic Loss Reduction, 2010. *Home builder's guide*. This guide is a product of the ICLR Designed ... for safer living® homebuilding program, which specifies construction and design guidelines to increase the resistance of homes to natural, catastrophe-level perils. Available at [http://www.iclr.org/images/builders\\_guide\\_2010\\_final.pdf](http://www.iclr.org/images/builders_guide_2010_final.pdf).

\*Larsen, L., N. Rajkovich, C. Leighton, K. McCoy, K. Calhoun, E. Mallen, K. Bush, J. Enriquez, C. Pyke, S. McMahon, and A. G. Kwok, 2011. *Green Building and Climate Resilience: Understanding impacts and preparing for changing conditions*. Prepared jointly by the University of Michigan and the U. S. Green Building Council. This report summarizes recent scientific knowledge of the impacts of climate change on the built environment and identifies design, construction and operation strategies that can increase resilience. Available at: <http://www.usgbc.org/sites/default/files/GreenBuildingClimResil.pdf>.

Newman, J., M. Springer, T. Sheehan, J. Gravelin, L. Trouche, S. Slaughter, and A. Wilson, 2013. *Building resilience in Boston: Best Practices for Climate Change Adaptation and Resilience for Existing Buildings*. Prepared for the Boston Green Ribbon Commission Climate Preparedness Working Group. The report – although written for the Boston context – identifies options for increasing resilience of existing buildings

to flooding, heat, wind, and other climate hazards. Available at:

[http://www.greenribboncommission.org/downloads/Building\\_Resilience\\_in\\_Boston\\_SML.pdf](http://www.greenribboncommission.org/downloads/Building_Resilience_in_Boston_SML.pdf).

NYC Planning, 2013. *Coastal Climate Resiliency: Retrofitting Buildings for Flood Risk*. This resource was developed to help building professionals and the architecture and construction sectors increase the resilience of buildings in the floodplain. It is primarily of interest for the case studies on resilience retrofits for common building types, from bungalows to multi-family residential structures and mixed-use buildings. Available at: [http://www.nyc.gov/html/dcp/pdf/retrofitting/retrofitting\\_complete.pdf](http://www.nyc.gov/html/dcp/pdf/retrofitting/retrofitting_complete.pdf).

Sustainable Homes, 2014b. *Measures to incorporate when planning a retrofit. A guide for Registered Social Landlords*. Produced for the London Climate Change Partnership. 6 pages. Available at <http://climatelondon.org.uk/wp-content/uploads/2014/02/A-Checklist-for-Retrofits.pdf>.

Tesche, C., 2014. *Extreme Heat, Cool Buildings: A Review of Alternatives to Traditional Air Conditioning*. Produced for the City of Vancouver Sustainability Group. This report, produced through the Greenest City Scholar program, summarizes the literature on alternative strategies to traditional air conditioning, with an emphasis towards multi-unit residential buildings, and, in particular, retro-fitting existing buildings. Available at:

<http://sustain.ubc.ca/sites/sustain.ubc.ca/files/Sustainability%20Scholars/GCS%20reports%202014/Extreme%20Heat%20Cool%20Buildings%20-%20Review%20of%20Alternatives.pdf>.

## Case Studies Related to Climate Resilience and Buildings

Adaptation and Resilience in the Context of Change (ARCC) Network, 2014. *Design for Future Climate (D4FC) competition: project outputs for Phases 1 and 2*. The Design for future climate (D4FC) competition was set up by Innovate UK (formerly the UK Technology Strategy Board) to encourage the incorporation of climate change adaptation in the design of real construction and refurbishment projects in the UK. Through the competition, which ran between 2010 and 2014, Innovate UK allocated £5 million to approximately 50 projects. Projects addressed three themes: flooding, overheating, and building materials. The website enables users to search for project case studies related to building type e.g. offices, schools, hospitals, etc. It includes links to summary and detailed reports, and key contacts for each of the buildings studied.

Available at: [http://www.arcc-network.org.uk/design-for-future-climate/?utm\\_source=UKCIP+enews&utm\\_campaign=e3903c86be-12\\_UKCIP\\_news\\_for\\_December\\_201412\\_4\\_2014&utm\\_medium=email&utm\\_term=0\\_a7d6f30eab-e3903c86be-3615141](http://www.arcc-network.org.uk/design-for-future-climate/?utm_source=UKCIP+enews&utm_campaign=e3903c86be-12_UKCIP_news_for_December_201412_4_2014&utm_medium=email&utm_term=0_a7d6f30eab-e3903c86be-3615141)

\*CRG Building Consultants Inc., 2012. *Toronto Community Housing Building: 285 Shuter Street, Toronto Ontario*. Prepared on behalf of Toronto Community Housing. This report presents a climate change vulnerability assessment based on the Engineers Canada PIEVC Protocol for a 16-story apartment building constructed in 1964 and part of a portfolio of social housing. This case study is of value because it clearly demonstrates how to use the Canadian-designed PIEVC methodology (see PIEVC, 2011) to assess risk to and vulnerability of individual buildings. Available at:

[https://www1.toronto.ca/City%20of%20Toronto/Social%20Development,%20Finance%20&%20Administration/Shared%20Content/Tower%20Renewal/PDFs/climate\\_change\\_vulnerability\\_assmt\\_1.pdf](https://www1.toronto.ca/City%20of%20Toronto/Social%20Development,%20Finance%20&%20Administration/Shared%20Content/Tower%20Renewal/PDFs/climate_change_vulnerability_assmt_1.pdf).

Golder Associates, 2010. *Climate change vulnerability assessment for Infrastructure Ontario: Case Study Report*. This report describes the use of the Engineers Canada PIEVC Protocol to assess climate related vulnerability of three buildings in southwest Ontario. Available at [http://www.pievc.ca/sites/default/files/infrastructure\\_ontario-pievc\\_case\\_study\\_of\\_three\\_buildings\\_final\\_report.pdf](http://www.pievc.ca/sites/default/files/infrastructure_ontario-pievc_case_study_of_three_buildings_final_report.pdf).

Jones, K. and N. Brosnan. 2013. *A climate change adaptation strategy for Octavia Housing*. Final report to the UK Technology Strategy Board. 71 pp. This case study from Innovate UK's Design for future climate program describes an approach to resilience planning for an entire portfolio of buildings. While this may be the only example of resilience planning for a portfolio, the case study is complex. Available at: <http://www.arcc-network.org.uk/wp-content/D4FC/D4FC48-Octavia-housing-full-report.pdf>.

Sustainable Homes, 2013. *Your social housing in a changing climate*. Produced for the London Climate Change Partnership (LCCP). 60 pages. This report explores the findings of a large-scale test of adaptation options in two high rise towers providing social housing. Climate resilience measures were introduced at the same time as a scheduled building upgrade. The report also provides details about the costs and benefits of the resilience/adaptation measures. Available at <http://climatelondon.org.uk/wp-content/uploads/2013/02/Your-social-housing-in-a-changing-climate.pdf>.

## **The Climate Resilience Planning Process**

Modern Built Environment Knowledge Transfer Network, 2013. *Guidance for making the case for climate change adaptation in the built Environment*. Prepared for Climate Ready. This report provides guidance to planners, developers, and designers working in the built environment sector in the UK on how to: i) develop and communicate the business case for climate change adaptation, and ii) realise developments which are resilient to the effects of a changing climate. It is applicable to both new development and retrofits, and for building and landscaping projects. The Guidance refers readers to many tools that are useful only in the UK context, and is therefore primarily of value for the insight it provides into the broader adaptation/resilience planning process. Available at: <https://connect.innovateuk.org/documents/3239554/6021573/Climate%20Change%20Adaptation%20Business%20Case%20Guidance>.

\*Public Infrastructure Engineering Vulnerability Committee (PIEVC), 2011. *PIEVC Engineering Protocol*. Developed by Engineers Canada, the PIEVC Engineering Protocol introduces a five step process to analyze the engineering vulnerability of an individual structure (e.g. a building), or an infrastructure system (e.g. a potable water treatment and supply system) to current and future climate parameters such as extreme heat or extreme rainfall. Summary of the proprietary tool available at: <http://www.pievc.ca/assessments>. This website includes a list of links to case studies based on use of the protocol. [Two of these case studies are also listed in this resource guide as CRG Building Consultants (2012) and Golder Associates (2010).] Available at: <http://www.pievc.ca/assessments>.

## The Value of Resilient Buildings

\*Innovate UK (formerly known as the Technology Strategy Board), 2014. *The business case for adapting buildings to climate change: niche or mainstream?* 12 pages. This executive summary of a longer report is based on evidence from Innovate UK's Design for Future Climate programme and is aimed at those working in building design, construction and associated policy and regulatory areas. Available at: <https://www.gov.uk/government/publications/the-business-case-for-adapting-buildings-to-climate-change>.

\*Sustainable Homes, 2014a. *The Business Case: Incorporating adaptation measures in retrofits. A guide for Registered Social Landlords*. Produced for the London Climate Change Partnership. 6 pages. This short document summarizes information about the costs and benefits of adaptation from Sustainable Homes (2013), listed elsewhere in this resource list. Available at <http://climatelondon.org.uk/wp-content/uploads/2014/02/The-Business-Case.pdf>.

## Information about Future Climate in British Columbia

\*Pacific Climate Impacts Consortium (PCIC), 2013. *Plan2Adapt*. Climate change impacts do not affect every region of British Columbia in the same way. The Plan2Adapt web-based tool generates maps, plots, and data describing projected future (2030s, 2050s, and 2080s) climate conditions for regions throughout British Columbia. Available at <http://www.pacificclimate.org/analysis-tools/plan2adapt>.

Charron, I., 2014. *A Guidebook on Climate Scenarios: Using Climate Information to Guide Adaptation Research and Decisions*. Ouranos, 86 p. This resource is intended to familiarize decision-makers with future climate information. It is aimed at all actors involved in climate change adaptation, from those in the early stages of climate change awareness to those involved in implementing adaptation measures. The guide allows users to engage more easily with climate service providers like the Pacific Climate Impacts Consortium, and to become more critical of the information that is provided to them. Available at: [http://www.ouranos.ca/media/publication/352\\_GuideCharron\\_ENG.pdf](http://www.ouranos.ca/media/publication/352_GuideCharron_ENG.pdf).

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