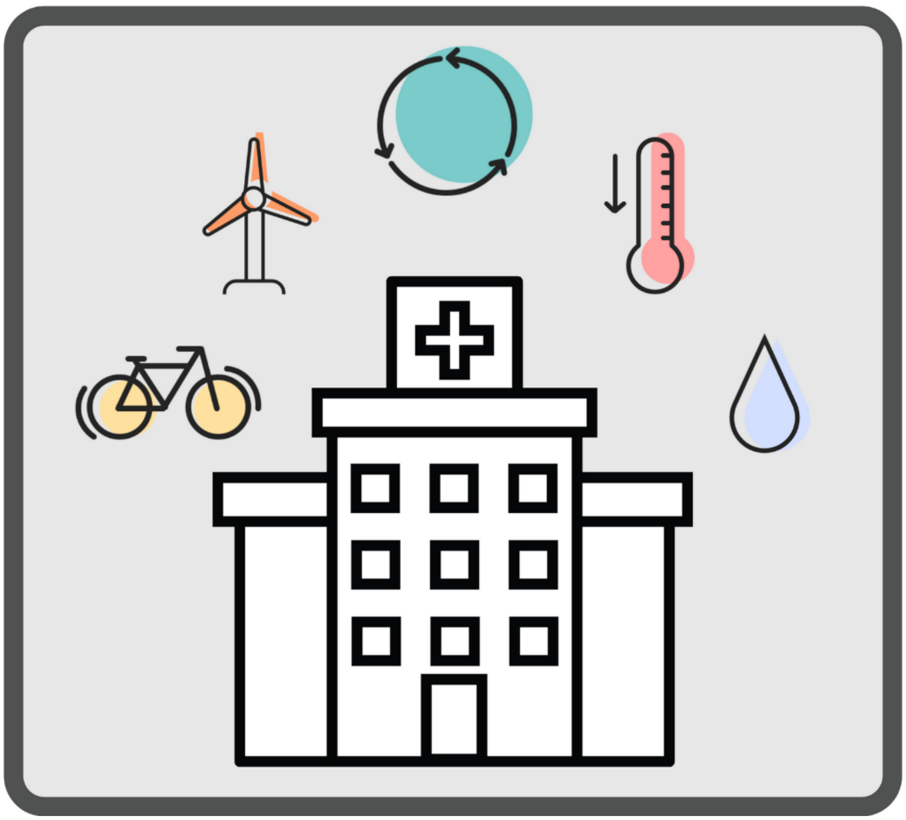
Low Carbon Resilience and Environmental Sustainability Guidelines for Health-care New Construction



This is a 'living' document and will be regularly updated to reflect best practices in health-care new construction. The most up-to-date version can be found at www.bcgreencare.ca/resource/guidelines

Document Updated: March 21, 2022

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Introduction

Purpose and Goals

The purpose of the *Low Carbon Resilience and Environmental Sustainability Guidelines for Health Care New Construction (the "LCRES Guidelines")* is to provide a set of recommendations to inform the detailed design phase of new and replacement construction for acute and long-term care facilities. This document is meant to inform engineers, coordinators, architects, contractors and operators, planners and other members of the project team in the development of project components specific to the Statement of Requirements and the Low Carbon Resilience and Environmental Sustainability Scope of Work.

The goal of the LCRES *Guidelines* is to give direction, and to provide recommendations and specifications to project teams that enable the highest standard of human and environmental health within the health organization facilities.

Key references for the *LCRES Guidelines* include:

(i) Ministry of Health *Carbon Neutral and Climate Resilient Health Facilities* policies 11, 12 and 14;

(ii) *Low Carbon Resilience and Environmental Sustainability Scope of Work for New Construction Business Planning* for Fraser Health, Providence, PHSA, and Vancouver Coastal Health;

(iii) *Climate Resilience Guidelines for B.C. Health Facility Planning & Design* (December 2020, v1.1), and *Establishing Design Conditions for Climate Resilient Planning and Design of Health Facilities in British Columbia* (October 2020, v1.0);

(iv) Health organization energy and environmental sustainability goals and targets;

(v) Provincial *CleanBC: Roadmap to 2030* and *Climate Change Accountability Act*

> Fraser Health, Providence Health Care, Provincial Health Services Authority, and Vancouver Coastal Health will each
>
> *Act as a leader with respect to environmental stewardship while engaging the health-care community in a collaborative approach towards sustainability.*
>
> Health Organization Environmental Sustainability Policies [1]

[1] https://bcgreencare.ca/resource/environmental-sustainability-policies/

Summary of Low Carbon, and Environmental Sustainability, and Climate Resilience

Health-care facilities need to be resilient to the impacts of a changing climate, to be built and operated with reduced greenhouse gas emissions, and to have reduced negative impacts on long-term human and environmental health and wellness. In order to achieve this, there are requirements and directions at the provincial health-care sector- and health-care organization-level (Figure 1).

At a high level, the *CleanBC: Roadmap to 2030* provides the structure and direction to reduce carbon emissions. All new construction should align with this roadmap to meet provincial targets and objectives, and to avoid future infrastructure upgrades.

The Ministry of Health: Capital Health Policy Manual has three policies that link directly to Environmental Sustainability, Low Carbon, and Climate Resilience; Policy 11: Environmental Sustainability and LEED, Policy 12: Carbon Neutrality and Climate Resilience, and Policy 15: The Use of Wood in Health Care Facilities.

In addition, Fraser, Providence Health Care, Provincial Health Services Authority, and Vancouver Coastal Health each have goals and targets specific to climate change, energy and carbon, materials, transportation and water (Appendix A).

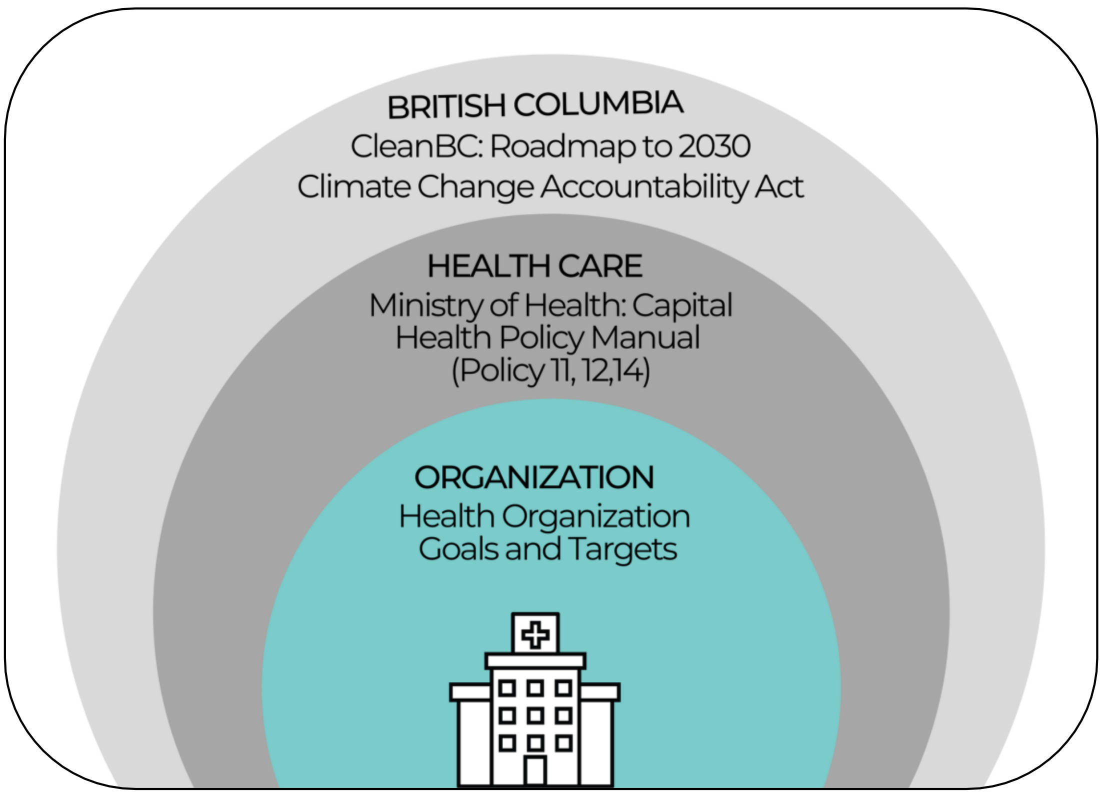


Figure 1 Various levels of Low Carbon, Environmental Sustainability, and Climate Resilience requirements and guidance for B.C. health-care organizations

Low Carbon
Low carbon design indicates a shift away from conventional fossil fuel-supplied energy systems to incorporate alternatives such as electrification, renewable fuels and low carbon district energy. New and replacement construction facilities should be planned and designed to minimize the production of greenhouse gas emissions resulting from the construction and operations of the facilities.

Environmental Sustainability

Environmentally sustainable health systems improve, maintain or restore health outcomes, while minimizing negative impacts on the environment and leveraging opportunities to restore and improve it for the benefit of the health and well-being of current and future generations

B.C. health organizations are committed to environmental sustainability to achieve the government's mandate and to benefit staff, patients and communities through improved environmental practices.[2]

Climate Resilience

Climate resilient health-care facilities are able to anticipate, respond to, cope with, recover from and adapt to climate-related shocks and stresses to bring ongoing and sustained health care to their target populations, despite a changing climate.

B.C. health authorities are committed to working to understand and manage risks associated with climate change, and developing strategies to adapt over time.[3]

Leadership in Energy and Environmental Design (LEED)

Design strategies brought forward for recommendation should be evaluated separately from but in alignment with the LEED process. See the LEED section in this document for more information.

See Appendix B for a Glossary of Terms

[2] Ministry of Health, Health Capital Policy Manual, Policy 12: Environmental Sustainability and LEED Gold Certification
[3] Ministry of Health, Health Capital Policy Manual, Policy 12: Carbon Neutral and Climate Resilient Health Care Facilities

Detailed Design

Throughout the different phases of project delivery, best practices around Low Carbon, Environmental Sustainability, and Climate Resilience should be considered and applied within the project planning, design, and construction phases (Figure 2).

The *LCRES Guidelines* and the *Climate Resilience Guidelines for B.C. Health Facility Planning & Design* v1.1 should be used to embed these principles within the detailed design phase. These guidelines can also service to inform high level master planning and site planning exercises to understand the desired outcomes for optimal building construction.

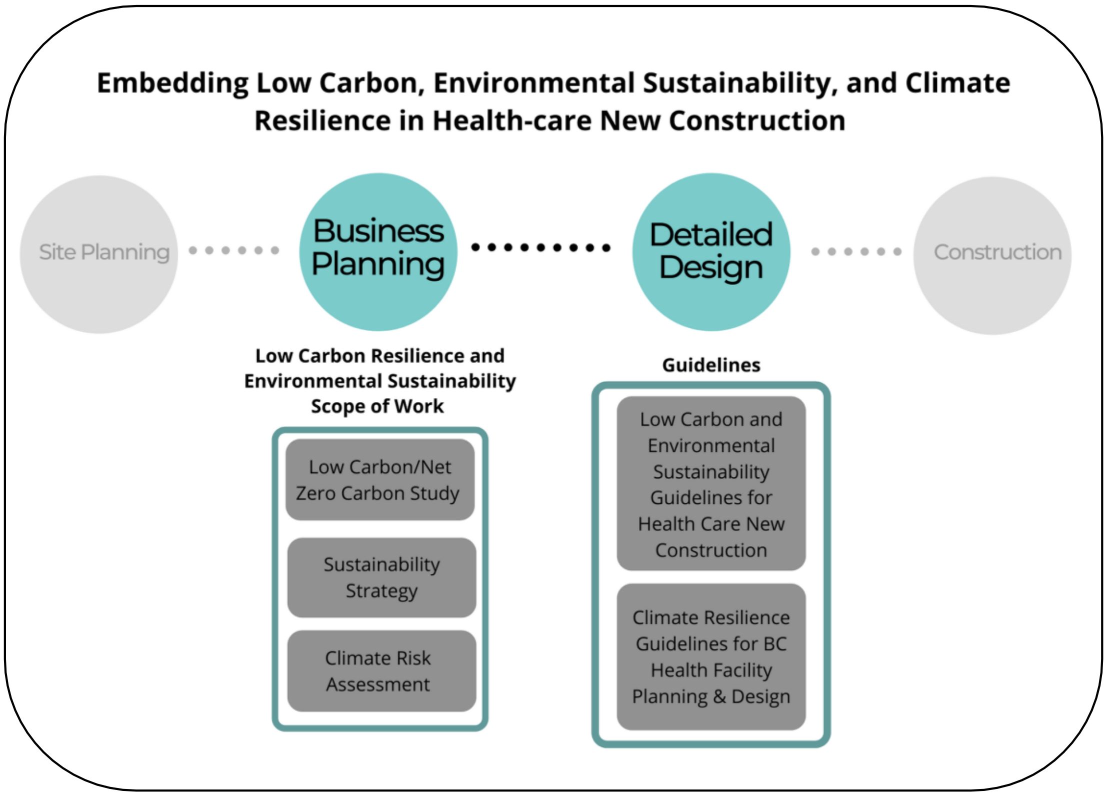


Figure 2 The different avenues by which Low Carbon, Environmental Sustainability, and Climate Resilience is embedded in different phases of capital project delivery

Procurement

Procurement is not covered within the *LCRES Guidelines*, though may have potential overlap depending on the structure of project phases (pre or post-detailed design). It is recommended to embed any performance related requirements (including energy, carbon, water, waste, etc.) into the procurement phase. Performance targets should be developed in alignment with the design intentions of this document. Specifically, a document outlining performance guarantees for energy and carbon should be incorporated in the procurement phase. An Independent Energy Consultant should support the development of these targets and support incorporating Measurement and Verification (M&V) phases for detailed design and new construction in alignment with IPMVP Volume I-III (Appendix C). Additionally, within LEED, certain credits may be pursued that are relevant to the procurement phase.

Low Carbon

Operational Emissions (Energy)

Key elements and detailed design considerations around energy efficiency and low carbon solutions should be carried forward from the business planning reports. In building on this initial information set, the detailed design phase should seek to achieve an optimized health-care facility, enabled by incorporating:

- Performance targets
- Technical design recommendations
- Commissioning
- Energy modelling

Performance Targets

If performance targets are a part of the contractual requirements for design and construction, the following targets should be considered in the detailed design:

- **Total energy target (MWh/year)**
    - Reported based on a combination of benchmarking, end-use breakdown analysis, energy modeling, and Energy Use Intensity (EUI) analysis converted to MWh.
- **Utility cost target ($/year)**
    - Reported based on energy target parameters with agreed cost rates for electricity and natural gas.
- **Thermal energy demand target (MWh/year)**
    - Annual heating energy demand for space conditioning and conditioning of ventilation air that is output from any and all types of heating equipment.
    - Reported based on understanding of relevant Thermal Energy Demand Intensity (TEDI) targets and converted to MWh.
- **Carbon target (tCO_2e/year)**
    - Reported based on the targeted total energy target and preferred distribution between fuel source options.

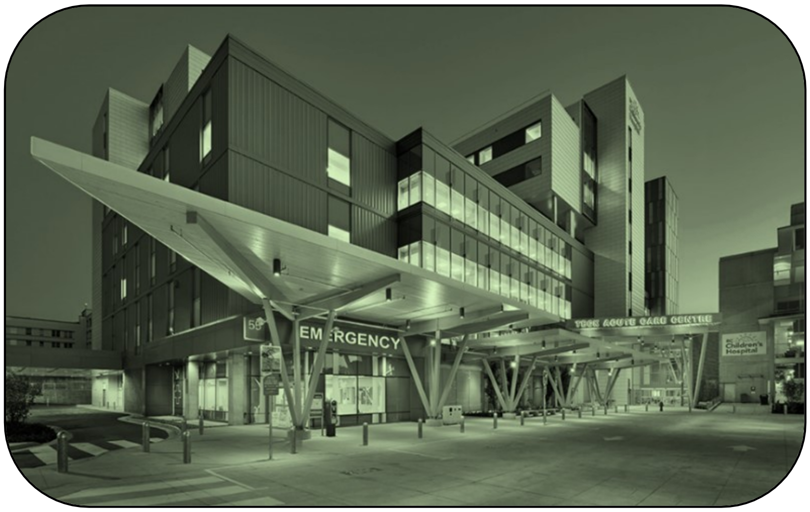


Figure 3 The Tech Acute Care Center is a successful example of performance targets achieving low carbon.

Technical Design Recommendations

All recommendations below are in addition to energy performance requirements as specified by B.C. Building Code or municipal bylaws.

Mechanical Design Guidance

The building mechanical system design and operation should comply with the following energy performance requirements. These requirements are in addition to the below section specific recommendations and any other energy performance requirements required by code.

- Building recovered thermal energy should provide the first stage of heating (Figure 4).
- Compressor-based air-source and/or geo-source heat pumps should provide the second stage of heating
- No fossil fuels should be used (space heating loads, ventilation, or domestic hot water pre-heat) if heat is being rejected from the facility (by heat rejection equipment or as form exhaust / relief air).
- To maximize total system efficiency:
  - Heating systems should use the lowest heating fluid temperature to satisfy a load and return the lowest fluid temperature.
  - Cooling systems should utilize the highest fluid temperature to satisfy a load and return the highest fluid temperature.
- Exhaust/relief air systems over 945 L/s (2,000 cfm) should be equipped with heat recovery capable of reducing the leaving air temperature to no higher than 9°C at all outdoor air conditions. Effort should be made to minimize the amount of smaller exhaust/relief air systems below 945 L/s (2,000 cfm), instead, smaller exhaust/relief systems should be grouped together in larger exhaust/relief air systems when allowed by code to improve performance of heat reclaim systems.

- Heat reclaim should take precedence over air-side and water-side economizing (i.e. "free cooling"). Economizer logic should be used only when the building cannot benefit from the heat reclaim.
- Heat reclaim should be holistically available for any building heating load.
- When possible, utilize direct heat transfer of thermal energy from reclaim source to load so long as the direct heat transfer system can reduce exhaust leaving air temperature to no higher than 9°C at all outdoor air conditions, otherwise a combination of direct and indirect heat recovery should be utilized.
- Demand based control logic should be implemented to automatically lower heating temperatures and raise cooling temperatures
- Spaces listed in CAN/CSA-Z317.2, Special requirements for heating, ventilation, and air-conditioning (HVAC) systems in health care facilities, Table 1: HVAC Design Criteria, that require a humidity range of 30% - 60%, should instead be targeted at 40% - 60%.

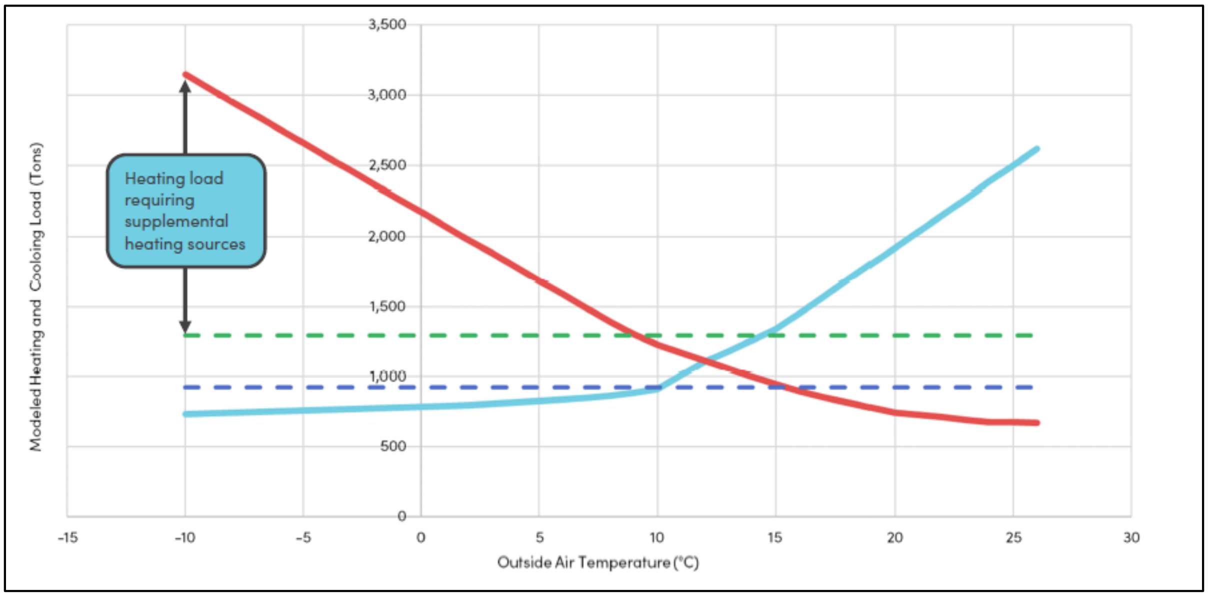


Figure 4 Model of thermal recovery. Heating (red) and cooling (light blue). Dashed lined indicate options for heat recovery load.

HVAC Design Recommendations

- All mechanical systems should incorporate heat and energy recovery ventilation where possible (greater than 75% efficiency), in alignment with ASHRAE 90.1.
- All mechanical systems should be designed to 2050 climate projections and sized for optimal flexibility to 2080 climate projections. Refer to climate projections outlined in *Establishing Design Conditions for Climate Resilient Planning and Design of Health Facilities in British Columbia* v1.0 (Appendix D) when determining design conditions.
- Air handling units should have capability to recirculate 100% of indoor airflow to reduce wasted energy and to minimize impact when outdoor ambient air conditions are non-ideal, while

maintaining parameters specified on HVAC design criteria on CAN/CSA-Z317.2. Consideration should be given for the likelihood of operating with 100% recirculated air for extended periods when designing filter systems for the AHUs.

- Air handling units should be designed to operate with mixed air during normal operation (when allowed by CAN/CSA-Z317.2.); these units should also have the capability of operating efficiently when operating at 100% Outdoor Air (O/A). This will require exhaust air heat reclaim systems to be sized for the corresponding exhaust air flow rates when operating supply air systems at 100% O/A.
- Design, when possible, for exhaust air to come through a central plenum with heat recovery coils tied to a heat recovery chiller or heat pump.
- Explore design opportunities to connect lab/data centre heat rejection to central building heating, to maximize heat recovery.
- Integrate mechanical design into a central distribution, if building spaces incorporate individually zoned heating and cooling spaces for building occupants.
- Use variable speed drives on terminal device pumps and fans to maintain system design pressure under variable flow conditions.

Mechanical Plant Recommendations

- Prioritize low carbon electric solutions for heating/cooling when feasible, including:
    - heat recovery chiller
    - Air-to-water heat pump
    - Air-to-water heat pump water heater
    - Ground source heat pump
    - Air-to-air rooftop heat pump
    - Water-to-water heat pump
    - Exhaust air heat recovery heat pump
    - Sewage heat recovery heat pump
- Compressor-based heating systems should be prioritized
    - Electric boilers and water heaters should be considered only when required to provide supplemental heating for compressor-based heating systems.
- Conduct a comparative analysis of Renewable Natural Gas with various scenarios to optimize use, including peak loads and back up systems.
- Space and water heating equipment should be at least 100% efficient, in alignment with CleanBC. Additional plant capacity beyond peak loads during normal operation (i.e. sizing for catastrophic events) is exempt from this recommendation.
- Heating and cooling plants should be sized to reflect the seasonal nature of heating and cooling loads, to allow efficient operation under varying loads. Heating plants should be designed to modulate via a combination of equipment selection and controls.
- Consideration should be given to determine how frequently a facility might be running at 100% O/A and to sizing the heat recovery system accordantly to maximize heat recovery during typical operation.

- Heating and cooling equipment should be located in close proximity and ideally tied together to optimize heat recovery. Design should incorporate all simultaneous heating and cooling loads under the first stage of equipment, with dedicated heating/cooling equipment providing the peak loads.
- Designs should integrate renewable energy sources when financially feasible.

Building Envelope Recommendations

- ASHRAE 90.1 2019, Energy Standard for Buildings should be used as a guideline when developing the building envelope.
- Passive House design strategies should be considered including:
    - Continuous insulation throughout envelope without thermal bridging.
    - Airtight building envelope, preventing loss of conditioned air.
    - High-performance windows doors and solar gain management to minimize overheating during cooling season and maximize solar gain during heating season.
    - Design envelope to minimize demand on space conditioning systems.

Control System Recommendations

- ASHRAE Guideline 36, High-Performance Sequences of Operation for HVAC Systems should be used as a guideline when developing control sequences for the HVAC systems. Where conflicts or omissions exist between the ASHRAE Guideline 36 and CAN/CSA Z317.2, the CSA code should take precedent.
- Long term trending for with a minimum of 15-minute interval data should be captured by the control system for all inputs, outputs and all set points.
- Energy meters should be installed to monitor thermal energy from primary heating and cooling systems and major thermal heating systems such as, but not limited, to AHUs, heat recovery systems and DHW.

Equipment Selection Recommendations

Equipment selection within detailed design should:

- Consider electrical equipment when possible, if not consider energy usage and prioritize Energy Star labeled equipment
- Avoid once-through cooling (OTC) equipment (including processing equipment) that uses potable water in a single pass as a cooling medium.
- Design for point of use electric humidifiers in air handling systems and process steam loads and avoid steam distribution infrastructure.
- Consider life cycle cost when analyzing and selecting equipment.
- Consider heat recovery chillers that can also operate efficiently in cooling mode when heat recovery is not required.

Electrical Recommendations

- Power service to site should allow for full site electrification for typical peak heating loads (i.e. not including catastrophic events) to align with mechanical plant design recommendations unless mechanical design is already fully decarbonized.
- Power Service should include allowance for electric vehicle infrastructure.
- Lighting controls should be non-addressable, unless in patient, doctor or nurse stations.
- Prioritize daylighting with sensors to control interior lighting when feasible.
- Light-emitting diode (LED) lighting should be use as the minimize standard for efficiency, avoid use of fluorescent technology.
- For interior/exterior lighting provide when feasible time clock, sensor or programmed switches.
- Provide motion sensor (or schedule) control for night lighting, exterior man doors and low use areas where economics are favourable.

Commissioning

In order to achieve optimal energy and carbon performance, a building commissioning plan is recommended to be developed as part of the detailed design phase. Commissioning for mechanical systems should be in compliance with:

- CSA Z317.2, Special Requirements for Heating, Ventilation, and Air Conditioning (HVAC) Systems in Health Care Facilities
- CSA Z8001, Commissioning of Health Care Facilities
- CSA Z320, Building Commissioning Standard
- LEED Fundamental and Enhanced Commissioning requirements, including an Independent Commissioning Authority.

Energy Modeling

An updated energy model is required as part of the detailed design, with the objective of carrying forward key design elements from the business plan phase. Energy models should be in alignment with required inputs and assumptions (Appendix E) which include requirements around site-specific future weather files. At a minimum, the updated energy model should include:

- Evaluated Energy Conservation Measures (ECMs) complete with energy use, carbon emissions, capital cost and operating cost performance indicators. Defined GHGI, TEUI, TEDI, EUI (including total electricity in MWh/year and natural gas in GJ/year), peak demand, absolute carbon emissions and energy cost performance ($/m2)
- All technical information required as part of both the CleanBC New Construction Program and FortisBC Commercial New Construction Program, including a final version of the energy model file.

Environmental Sustainability

Sustainability design strategies and objectives identified in the business plan phase for implementation and/or further investigation should be carried forward into the detailed design phase. In order to construct facilities that are contribute to environmental and human health, the recommendations within each of the following areas should be considered for incorporation.

Water

Minimizing water consumption reduces demand on natural systems, and demand on resources required to process and transport water to health-care facilities. In order to optimize a lower water building design, the following elements should be evaluated within the detailed design:

- Estimated whole building (indoor and outdoor) water use consumption (in m^3/year) to enable ongoing tracking of water use relative to expected.
- Water reduction strategies aligning (further detailed in Appendix F) with, but not limited to LEED, including:
    - end user water reductions
    - Water metering by system (potable, process, etc.)
    - mechanical systems water reductions
    - water reuse
- Faucet and sink design that work effectively and efficiently for the cleaning of hands while restricting splashing and the spread of aerosols. CSA Z317.1-16 should be followed, which includes requirements for plumbing installations including design, construction, commissioning, operation and maintenance.

Embodied Carbon

Carbon impacts from producing materials needed for construction can be a significant portion of building's lifetime carbon footprint (Figure 5). A Life Cycle Assessment (LCA) is recommended to be completed as part of the schematic design or detailed design phase. If completing an LCA, it is recommended to follow the approach outlined in the Canada Green Building Council's Zero Carbon Building (ZCB) Standard, and demonstrate at least 10% reduction of carbon emissions throughout the life cycle including upfront, in-use, and end-of-life stages.

Capital cost of embodied carbon reductions should be compared against operational carbon reductions to make informed decisions on best cost for overall carbon reduction (\$/tonne CO_2). Refer to Appendix G for further details on aligning the scope of an LCA with the ZCB Standard.

Figure 5 The impact of upfront and operational carbon emission (Canadian Green Building Council)

Refrigerants Recommendations

Carbon emissions from refrigerant or air conditioning equipment results from the charging of equipment and from leaks during normal operations. In order to lower the impact of these emissions, buildings should be designed to include systems and equipment with both a low Global Warming Potential (GWP) and Ozone Depletion Potential (OPD) refrigerant and/or limited volumes of refrigerants. Designs should prioritize the lowest GWP refrigerant feasible (Figure 6).

Refrigerant Choices

This table compares various properties of both current and next-generation refrigerants. The efficiencies and capacity changes shown are based on the theoretical properties of the refrigerant alone, with all design variables held constant for objective comparison.

Past | Transitional | Lower GWP Solution | Ultra-Low GWP Solution

		Low Pressure			Medium Pressure				High Pressure					
		R-123	R-1233zd	R-514A	R-134a	R-513A	R-515B	R-1234ze	R-22	R-410A	R-466A	R-452B	R-454B	R-32
Flammability	ASHRAE Class	1	1	1	1	1	1	2L	1	1	1	2L	2L	2L
Toxicity[1]	ASHRAE Class	Higher (B)	Lower (A)	Higher (B)	Lower (A)	Lower (A)	Lower (A)	Lower (A)	Lower (A)	Lower (A)	Lower (A)	Lower (A)	Lower (A)	Lower (A)
	OEL	50	800	320	1000	650	810	800	1000	1000	860	870	850	1000
Efficiency (COP)		8.95	8.85	8.91	8.47	8.28	8.32	8.45	8.48	7.99	8.00	8.14	8.15	8.22
Capacity Change		baseline	~35% gain	~5% loss	baseline	similar	~25% loss	~25% loss		baseline	~2% loss	~2% loss	~3% loss	~9% gain
GWP[2]		79	1	2	1300	573	298	1	1760	1924	703	675	466	677
Atmospheric Life		1.3 years	26 days	22 days	13.4 years	5.9 years	3.1 years	16 days	11.9 years	17 years	5.8 years	5.5 years	3.6 years	5.2 years

[1]None of the refrigerants shown in the table are considered "toxic" or "highly toxic" as defined by the IFC, UFC, NFPA 1 or OSHA regulations.
[2]GWP values reported are per the Fifth Assessment Report (AR5) of the IPCC (Intergovernmental Panel on Climate Change).

Figure 6 Refrigerant options and resulting Global Warming Potential

Materials and Waste Prevention

Design for Disassembly

Designing for disassembly is one of the most impactful design decisions to increase facility waste diversion. Planning for the end-life of individual infrastructure components within life-cycle projections can mitigate future environmental impacts, costs, and inefficiencies associated with replacement or retrofit requirements for entire systems.

Designing for disassembly includes designing and selecting materials, equipment, and components that:

- Are upgradeable
- Are repairable
- Are replaceable without affecting the surrounding components
- Can be separated into components and waste streams for end-of-life disposal and reuse

Operational Reuse and Circularity

The design of clinical and non-clinical spaces should ensure that the space required for operational reuse is being considered during the detailed design. Modifications to detailed design should be made for the use of reusable items instead of disposable ones.

Operational reuse may include:

- Reusable medical devices
- Reusable food service-ware

Two key space considerations are the Medical Device Reprocessing Department (MDRD), which requires additional space and capacity to process reusable surgical devices, and the food services department, which requires additional space and infrastructure to process and store reusable food service-ware.

Typically, reusable products do not require additional storage space to what is already needed for disposable products. However, additional space considerations do need to be made for the collection, transport, and sterilization or reprocessing of items.

Medical Device Reprocessing Department Recommendations

- Design with consideration to medical device flow throughout the health-care facility (logistics of reprocessing and sterilization).
- Consider end-of use collection requirements for reusable materials for both in-house processing, as well as outsourced reprocessing.
  - Designs should include space for medical device collection at end-of-use, prior to transfer to Medical Device Reprocessing Department, or pick-up by outsourced reprocessing vendor.

Anesthetic Gas Scavenging Recommendations

- All facilities designed for use of anesthetic gases (i.e. operating rooms) should include anesthetic gas scavenging systems to capture waste gas

Food Services Recommendations

- Design with consideration to reusable food service-ware flow throughout the health-care facility (logistics of reprocessing and sterilization).
- Consider end-of-use collection requirements (i.e. end-of-use by patients, staff).
- Consider additional space and infrastructure needed to wash and store reusable service-ware.

Operational Waste Diversion

Detailed designs should include space requirements for waste collection and diversion (including mixed paper, mixed containers and organics), garbage and biomedical waste collection as per waste collection standards in Fraser Health, Providence, PHSA, and VCH. Adequate container spaces in the appropriate locations are necessary considerations for reaching waste-diversion targets and efficient waste collection.

All designs should refer to the *Waste Management Space Design Guidelines* (Appendix H) to ensure that appropriate operational waste measures are included in the facility. Waste-diversion considerations, including waste collection, flow, storage, and pick-up, should ensure that design will support a waste-diversion rate of 50% at all acute and long-term care sites.

All designs should refer to the *Waste Management Space Design Guidelines* (Appendix H)

Waste management design elements to be considered:

- Waste types generated by facility area
- Container needs and dimensions
- Waste station set-up
- Waste removal flow and storage

Figure 7 An example of garbage and recycling containers in a health-care setting

Healthy Materials

Construction Materials, Finishing, and Flooring

Many known harmful chemicals exist in construction materials, finishing and furnishing. While there may not be safe and/or approved alternatives to all chemicals or their associated materials, design should minimize the potential exposure of staff, patients and visitors during building occupancy, as well as contractors during building construction, to known hazardous chemicals.

In order to reduce the negative impacts on human and environmental health, designs should:

- Prioritize the reduction of Construction Chemicals of Concern (Appendix I)
- Avoid all furniture, finishing, and constructions materials that contain:
    - Formaldehyde
    - Per- and poly-fluorinated compounds (PFAs)
    - Polyvinyl chloride (PVC)
    - Halogenated flame retardants
    - Mercury, lead, cadmium, copper (where avoidable)
- Select safe and effective **finishing and building material options** for health-care facilities, including but not limited to:
    - Wet-applied paints and coatings should be low-emitting and meet both the California Department of Public Health (CDPH) Standard and the Volatile Organic Compound (VOC) limits in South Coast Air Quality Management District (SCAQMD) Rule 1113, or equivalent
    - Low-emitting sealants and adhesives should meet both the CDPH Standard and SCAQMD Rule 1168, or equivalent
    - Insulation products should meet the CDPH Standard, or equivalent, and batt insulation products should contain no added formaldehyde, including urea formaldehyde, phenol formaldehyde, and urea-extended phenol formaldehyde.
    - Composite Wood should be marked as low formaldehyde through either ULEF (Ultra-Low Emitting Formaldehyde) or NAF (No Added Formaldehyde) labelling under the US EPA TSCA Title VI rule.
    - New furniture and furnishing items should meet ANSI/BIFMA Standard e3, sections 7.6.1 or 7.6.2 (Furniture) or equivalent
    - NSF/ANSI 342 Wall Coverings
    - NSF/ANSI 347 Single Ply Roofing Membranes
    - Roofing and waterproofing materials applied on site should meet the VOC limits of California Air Resources Board (CARB) 2007 Suggested Control Measure (SCM) for Architectural Coatings, and South Coast Air Quality Management District (SCAQMD), Rule 1168, effective July 1, 2005
- Select safe and effective **flooring options** for healthcare facilities, including but not limited to:
    - Products that meet the CDPH Standard, or equivalent
    - Products that meet Healthy Flooring Criteria: https://noharm-uscanada.org/flooringlists
    - Products certified by standards indicating low negative impacts on human and environmental health (Greenguard Gold, Greenhealth, EcoLogo, FloorScore, Green Seal)

Transportation

A primary goal when considering site transportation should be the provision of transportation and commuting measures that reduce the dependence on and the necessity of using single occupancy vehicles, while actively supporting and enabling alternative forms of transportation.

Designs should be developed in consideration of transportation programs available to staff that include but are not limited to:

- Transit Incentive Programs
- Hospital Shuttle Programs
- Carpooling Programs
- Car-share Options

Transportation Accessibility

Designs should consider the location of the site, its connectivity and the different transportation modes by which staff, patients and visitors will be commuting and travelling to the site.

In order to support staff, patient and visitor transportation that has reduced negative impacts on environmental health and benefits to general health and wellness, designs should:

- Prioritize multi-modal transportation in design.
- Plan for transportation amenities that provide access to and influence future sustainable transportation behaviour, not only based on current demand.
- Account for existing future transportation programs, and how they will apply to infrastructure should be designed for what we want, not what we have.
- Consider municipal transportation networks (cycling infrastructure and routes, frequent transit networks), as well as plans for infrastructure expansion) to understand site accessibility requirements.

Bicycle Facilities and Active Transportation

Designs should ensure that active transportation is supported and encouraged, by providing appropriate infrastructure and amenities for both staff and the public. Transportation Demand Management Plans should consider how the design will facilitate the overall reduction of single-occupancy vehicle use, and how it will support staff and the public in choosing sustainable and healthy transportation modes.

> Bicycle storage and facilities should be designed according to *Design Guidelines – Bicycle Parking Facilities* (Appendix J)

In order to support active transportation, designs should:

- Design bicycle storage facilities according to *Design Guidelines – Bicycle Parking Facilities* (Appendix J) and with consideration to additional modes of active transportation.
- Consider the commissioning of a bike assessment to evaluate a site's bicycle and other transportation amenities and facilities, and identify areas of improvement.

Car-share and Carpool

- Whether a site is appropriate for a car-share parking stall will depend on the location and municipality of the site. Car-share parking stalls should be easily accessible to the public, and are not appropriate for underground parking or parkades that may be more difficult for members of the public to access from the street.
- Designs may want to consider the creation of dedicated parking spaces for carpool vehicles.

Electric Vehicle Charging

There is currently no standard for the installation of electric vehicle (EV) charging stations within or between Fraser Health, Providence, PHSA, or VCH (i.e. # of charging stations per FTE).

> Electric vehicle charging installations should follow the *Technical Recommendations for Electric Vehicle Charging Stations* (Appendix K)

Public and Staff Charging

Staff charging should be prioritized over public charging. It is general best practice for owners of electric-vehicles to charge at home, while relying on workplace charging only to 'top-up' their charge, or on an as-needed basis.

All designs should be built to ensure that facilities enablers and not barriers to the ownership and use of electric vehicle. All designs should be prepared for the federal EV target of 100% light-duty sales by 2035.

Fleet Vehicle Charging

As public sector organizations, the B.C. health organizations are required to transition to Zero-Emission Fleet Vehicles by CleanBC (ZEVs will account for 100% of light-duty acquisition by 2027).

In order to prepare for the electrification of health authority fleet for light-duty vehicles and for eventual medium- and heavy-duty vehicles, facilities designs should:

- Consider the current and future fleet vehicle requirements at the site
    - Health organization fleet
    - Hospital shuttle bus
- Assume, at minimum, that all fleet vehicles will require overnight charging by Level 2 (208/240V) charging stations.

- Include designated fleet vehicle parking locations, separate from staff and public parking/charging.
- Ensure designate parking locations are provided with energized outlets with the capacity for Level 2 charging (208/240V).

Ambulance Charging

Designs should consider the eventual future demand for ambulance electrification. Ambulance electrification will require a Level 3 (480/277 V) "Fast Charging" Station, for exclusive use. Designs should consider and prepare for the space and electrical requirements of these charging stations at hospital emergency room ambulance bays.

Designing for the Future

All designs should accommodate future demand for electric vehicle charging. In order to ensure that facility sites are prepare for future demand and are "Electric vehicle ready" they should:

- Build expansion options into any planned electric vehicle charging installation, by installing additional electrical conduit and 240 V energized outlets (Figure 8).
- Dedicate separate electrical panels to electric vehicle charging installations, to ensure that there is reserved electrical capacity for future expansion and that building operations are not compromised by or limiting to EV charging capacity.

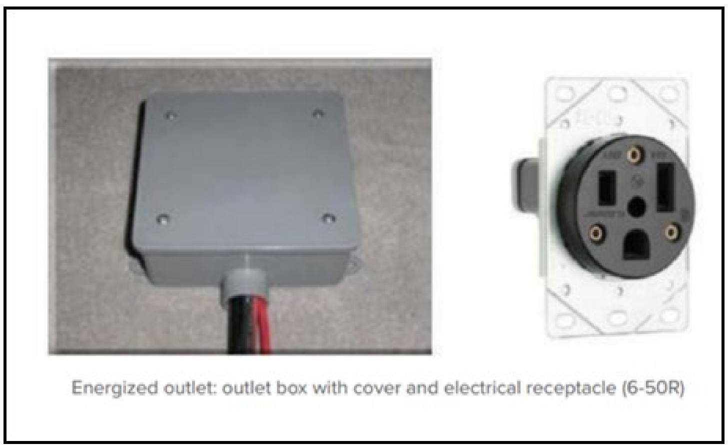


Figure 8 An energized outlet, intended for the eventual installation of a Level 2 electric vehicle charging station (240V)

Climate Resilience

It is imperative to understand climate risks and impacts during capital project delivery, and for operations from the beginning to end of a facility's service life. While it is necessary to manage climate risks and enhance resilience over the lifetime of a facility, the planning and design phases represent the most impactful and effective opportunities in the project and services delivery.

This document summarizes key information on considering climate risk and resilience for new and replacement construction projects, with additional details and systematic instructions available in the companion *Climate Resilience Guidelines for B.C. Health Facility Planning & Design* v1.1 (Appendix L)

Understanding and managing climate risk begins with an exposure screen, typically completed during the high level master plan phase. Within the business planning phase, a preliminary climate risk assessment should be conducted to identify resilience requirements and potential compliance measures, which will serve as a foundation within the detailed design.

The detailed design phase should include a resilient design review to validate the preliminary climate risk assessment, to confirm relevance to design project, to identify potential gaps, and to apply learnings to design.

Within this process should be a highlight of how the design addresses climate risks and resilience requirements, and where enhanced resilient design strategies may be necessary. This is an opportunity to review climate risks in relation to proposed designs, validate proposed resilient design strategies and adaptation pathways, and maximize alignment with emissions reduction and/or energy conservation measures.

Outcomes should be summarized in a resilient design brief that, at a minimum:

a. Lists resilient design strategies included in the design, recommended for future consideration, and excluded from design
b. Indicates resilient design strategies that address climate risks and impacts identified in previous phases
c. Summarizes relevant impacts to the facility and identifies risk over facility life
d. Identifies potential for synergies, co-benefits, conflicts and trade-offs
e. Cross-references resilient design strategies per Statement of Requirements
f. Describes residual risks to be managed during occupancy until facility end-life

Supplementary information should include:

a. Annotated list and synthesis of:
   - Data and information reviewed
   - Climate hazard and risk resources consulted
   - Critical services and infrastructure considered
   - Engagement conducted during this phase, including stakeholders consulted
b. Summary tables and narrative analysis of other aspects considered, including:
   - Context of the project
   - Relevant climate hazards and those deemed out of scope for the project
   - Recommended design criteria, including future climate projections

Leadership in Energy and Environmental Design

In order to align with Ministry of Health: Capital Health Policy Manual Policy 11, health-care facilities are required to achieve LEED Gold or equivalent certification. To enable this processes a LEED v4 scorecard template can be found in Appendix M, this template should be used as a reference point to developing the project specific LEED strategy.

The LEED v4 scorecard template can be found in Appendix M

LEED credits have been prioritized based on their alignment with the Low Carbon, Environmental Sustainability and Climate Resilience principles outlined in the LCRES guideline, and with prescriptive requirements only to comply with provincial mandates.

In order of priority:

1. Priority Credits
2. Recommended Credits (or use alternative compliance)
3. Should Investigate
4. Not Recommended

The LEED Scorecard Template also indicates **Related Credits**, where multiple credits can be investigated as part of a single exercise.

Supports Low Carbon
Supports Environmental Sustainability
Supports Climate Resilience

LEED-Gold Checklist for Health-care New Construction

LEED v4 BD+C: HEALTHCARE

Date Issued: March 09, 2022 (DRAFT)

Priority Credits	Recommended (or use alternative compliance)	Should Investigate	Not Recommended		Low Carbon	Environmental Sustainability	Climate Resilience
28	44	25	23	Project Total	Co-Benefits		

1. **Priority Credits**
    - Credits with *credit intents* and *credit requirements* that align very strongly with the Low Carbon, Environmental Sustainability and Climate Resilience goals of Fraser Health, Providence, PHSA, and VCH. Achieving these LEED credits should be prioritized.
2. **Recommended (or use alternative compliance)***
    - Credits with *credit intents* that align very strongly with Low Carbon, Environmental Sustainability, and Climate Resilience goals but *credit requirements* may not directly support these goals or may pose compliance challenge for projects. Achieving these *credit intents* should be prioritized and if appropriate, the credit should be targeted in support of the project's LEED Gold strategy. Where these *credit requirements* are deemed unachievable by project teams, the LCRES Guidelines' Low Carbon, Sustainable Design and Resilience strategies should be treated as acceptable alternatives.
3. **Should Investigate**
    - Credits with *credit intents* that align with the Low Carbon, Environmental Sustainability and Climate Resilience goals of Fraser Health, Providence, PHSA, and VCH, but may not be possible for all projects based on site location, architectural massing, and/or other factors. These credits should be investigated, and if appropriate, should be targeted in support of the project's LEED Gold strategy.
4. **Not Recommended**
    - Credits that are not required, project teams can elect to evaluate on a per-project basis.

To further support development and implementation of the project's LEED Gold strategy, the LEED Scorecard Template includes a **Coordination Timeline**, which outlines which credits should come into focus during the Details Design Phase.

LEED v4 vs v4.1

At the time of this document's publication, project teams have the option to register under LEED v4 or LEED v4.1. The USGBC has noted that Projects that pursue LEED v4 have the option to swap in V4.1 credits on a credit-by-credit basis. As a result, the LEED Scorecard Template references where an appropriate v4.1 pathway exists.

APPENDICES

Appendix A: Energy and Environmental Sustainability Goals, Targets and KPIs for the Fraser Health, Providence Health Care, Provincial Health Services Authority, and Vancouver Coastal Health

Refer to online Appendix at www.bcgreencare.ca/resource/guidelines

Appendix B: Glossary of Terms

Active Transportation
Modes of transportation that are human-powered (i.e. walking, cycling), that may required the use of a device for support (i.e. mobility aids, e-bikes)

Carbon Emissions
Equivalent greenhouse gas emissions expressed in metric tonnes of equivalent carbon dioxide (tCO2e).

Carbon Footprint
Total amount of greenhouse gases that are generated by a given action.

Circularity
Also known as circular economy, refers to a model that emphasizes the reuse, sharing, and repurposing of goods, to discourage and delay disposal in the landfill, and create new economies for sharing and recycling

Demand based control logic
Control logic that reduces varies supply based on variable demand requirements over time.

Detailed Design Phase
The phase of planning that identifies the functional requirements and the arrangement of space at a detailed level, both within and between departments. Work in this phase will establish the layout for the buildings, confirm the assumptions in the functional program and establish the supporting building systems.

Electrification
Process of converting on-site fossil fuel driven energy loads to supply from electrical grid.

Embodied Carbon
The carbon emissions associated with the materials and construction processes throughout the lifecycle of a building or infrastructure, distinct from operational emissions.

Energy
Electrical and thermal energy used within, by or for the Facility, including electrical and thermal energy used within, by or for exterior elements connected to the Facility's electrical and thermal systems

Energy Conservation Measure (ECM)

A single initiative undertaken to reduce the energy consumption of a particular piece of equipment or a certain aspect of essential building services. The main purpose of energy conservation measures is to reduce the need of primary energy.

Energy Use Intensity (EUI)
An indicator of the energy efficiency of a buildings design, with energy use relative to building floor area.

Global Warming Potential (GWP)
The heat absorbed by any greenhouse gas in the atmosphere, as a multiple of the heat that would be absorbed by the same mass of carbon dioxide.

Heat reclaim
Capturing excess or waste heat and reusing for another purpose.

Life Cycle Assessment
A cradle to grave analysis of the environmental impacts within all stages of a product's life.

Low Carbon
The use of energy sources that have a minimal or reduced output of carbon emissions

Measurement and Verification (M&V)
Process of planning, measuring, collecting and analyzing data for the purpose of verifying and reporting on energy savings.

Modular Construction
A subset of lean manufacturing that allows both mass customization and process standardization, thus reducing material water and build time compared to traditional onsite construction techniques.

Multi-modal Transportation
Transportation planning that designs for a diverse range of transportation options, as well as the connections between those options.

Net Zero Emissions
Reducing emissions from operations to as close to zero as possible and balancing out any remaining emissions with an equivalent amount of carbon removal.

New Construction
New buildings and structures including constructed additions to existing buildings. Not including the reconstruction of existing buildings.

Once-through cooling
When water passes through condensers and then to drain, for the purpose of removing waste heat. The process is known to waste large amounts of water.

Ozone Depletion Potential (ODP)
Measure of how much damage a chemical can cause to the ozone layer.

Peak loads
The highest amount of energy that is consumed over a period

Recovered thermal energy
Any passive form of recovering heat for the purpose of reuse in the building environment.

Renewable Energy
On-site generation of energy from renewable sources which results in zero greenhouse gas emissions

Renewable Natural Gas (RNG)
Alternative to conventional natural gas that is interchangeable and supplied by FortisBC as a low carbon option.

Solar gain
Increase in thermal energy as it absorbs incident solar radiation.

Thermal bridging
When a material in the building envelope transfers heat at a greater rate than surrounding components.

Thermal Energy Demand Intensity (TEDI)
The annual heating energy demand for space conditioning and conditioning of ventilation air. This is the amount of heating energy that is output from any and all types of heating equipment, per floor area.

Waste Diversion
The percentage of waste materials that is not disposed of in the landfill or by incineration.

Water reuse
Method of recycling treated wastewater for use in other processes like irrigation or toilet flusing.

Variable speed drives
Devices that vary the speed of a normally fixed speed motor.

Zero Emissions Vehicle (ZEV)
A vehicle that produces no or low carbon emissions including battery electric vehicles (EV), plug-in hybrids (PHEV) and Hydrogen fuel cell vehicles.

Appendix C: Independent Energy Consultant Accountability Chart

Refer to online Appendix at www.bcgreencare.ca/resource/guidelines

Appendix D: Establishing Design Conditions for Climate Resilient Planning and Design of Health Facilities in British Columbia v1.0

Refer to online Appendix at www.bcgreencare.ca/resource/guidelines

Appendix E: Energy Modelling Requirements

Refer to online Appendix at www.bcgreencare.ca/resource/guidelines

Appendix F: Water Reduction Design Strategies

Plumbing and Fixtures

- Where feasible consider installation of metered faucets, foot pedals, and automatic motion sensors, particularly in clinical sinks, dirty utility sinks, and public washrooms.
- Review dual-flush features for macerators with bedpan washers.

Process Water

- Prioritize closed-loop systems instead of open-loop systems in processes like cooling towers and steam boilers
- Recover non-potable condensate in expansion tanks for reuse in heating and cooling processes and other operations to reduce potable water make-up and water-tempering demand
- Consider maintenance-free steam traps for steam systems.
- Install water meters to support monitoring and identification of further process optimization opportunities
- Consider alternative treatment systems that use less water in comparison to conventional water purification systems
- Consider dialysis units that can recycle, treat and reject water through reverse osmosis for use in irrigation
- Avoidance of once-through cooling (OTC) equipment that uses potable water in a single pass as a cooling medium
- Utilize where possible dry and adiabatic coolers over cooling towers in order to reduce water consumption and reduced legionella risks

Equipment

- Laundry Machines: Install front-loading ENERGY STAR models that can be reprogrammed to eliminate additional rinse cycles
- Icemakers: use ENERGY STAR air-cooled models
- Dishwashers: Select conveyor-type with load sensors
- Food Steamers: Select ENERGY STAR or boiler-less models

Irrigation

- Install smart irrigation systems with automated controls to adjust based on weather
- Consider using non-potable sources for irrigation like dialysis unit reject water or rainwater collected through cisterns

Appendix G: Aligning LCA scope with the Canada Green Building Council's Zero Carbon Building Standard

Life Cycle Assessment

A Life Cycle Assessment (LCA) analysis should include:

- All envelope and structural elements
    - Footings and foundations
    - Complete structural wall assemblies (from cladding to interior finishes, including basement)
    - Structural floors and ceilings (not including finishes)
    - Roof assemblies
    - Stairs
- Parking structures
    - Excavation and other site development, partitions, building services (electrical, mechanical, fire detection, alarm systems, elevators, etc.), and surface parking lots are excluded.
- New materials only (to encourage building material reuse)

Service life
Consistent with the requirements for the LCA of the proposed building, the baseline building should use a service life of 60 years.

Building equivalence
The baseline building should be equivalent to the proposed building. The following should be constant in both the baseline and proposed building:

- Operational energy use
- Operational energy use
- Gross floor area
- Functional use of space
- Building shape and orientation

Appendix H: Waste Management Space Design Guidelines

Refer to online Appendix at www.bcgreencare.ca/resource/guidelines

Appendix I: Chemicals of Concern: Construction Interiors

Refer to online Appendix at www.bcgreencare.ca/resource/guidelines

Appendix J: Bicycle Parking Design Guidelines

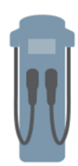
Refer to online Appendix at www.bcgreencare.ca/resource/guidelines

Appendix K: Technical Recommendations for Electric Vehicle Charging Stations

In order to ensure regional consistency and standardization across Fraser Health, Providence, PHSA, and Vancouver Coastal Health, design for electric vehicle (EV) charging stations should:

- Only consider Level 2 and Level 3 charging stations for both public/staff and fleet charging (Table 1). Level 1 (i.e. 120V, 'trickle charging') are no longer considered adequate power for the current vehicle charging demands.
- Select charging stations that utilize a web-based app (not a third party downloadable app) that is accessible through RFID cards or QR codes.
- Be consistent with EV charging station design and selection in other health-care facilities
- Ensure that all charging stations use an open network, with an Open Charge Point Protocol (OCPP).
- Ensure that all EV stations are equipped with standard connector types:
  - J1772 Level 2 (208/240V)
  - J1772 Combo (for fast chargers)
  - CHAdeMO (for fast chargers, if applicable)

Table 1 Technical specifications for Level 2 and Level 3 electric vehicles charging stations

	 Level 2	 DC Fast Charge
Electrical and Power Specifications	208/240 V, 40 Amp circuit 6.7-7.7kW	480/277 Volt 3-Phase, 80 Amp circuit 50 kW or more (up to 400 kW)
Estimated Range Added	40 km/hour	250 km/hour
Time to charge a 100-mile battery	4 hours	20-30 minutes

Appendix L: Climate Resilience Guidelines for B.C. Health Facility Planning & Design v1.1

Refer to online Appendix at www.bcgreencare.ca/resource/guidelines

Appendix M: LEED v4 BD+C: Healthcare, Gold Scorecard Template

Refer to online Appendix at www.bcgreencare.ca/resource/guidelines