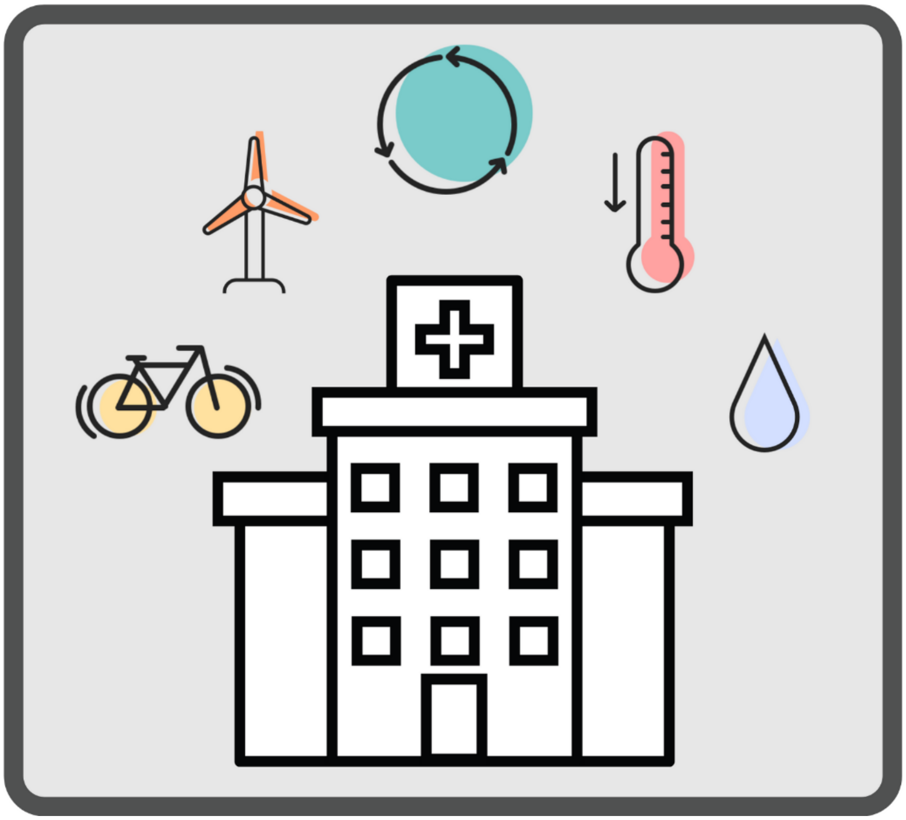
Low Carbon, Resilience and Environmental Sustainability Guidelines for Healthcare New Construction



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

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Version Control

Version Number	**Date Issued**	**Summary of Changes**
2022.03	21-March-2022	Original
2023.07	30-July-2023	Changes throughout, including Introduction, Project Planning (replacing Detailed Design), Project Delivery Method (replacing Procurement), performance targets, energy modelling, embodied carbon. Climate resilience and LEED sections have been updated to reflect new Provincial standards.

Introduction

Ownership of LCRES Guidelines

The *Low Carbon, Resilience and Environmental Sustainability Guidelines for Healthcare New Construction* (the "LCRES Guidelines") were created by the Energy and Environmental Sustainability team (EES), a regional collaboration team in the Facilities Management departments at Fraser Health, Providence Health Care, Provincial Health Services Authority and Vancouver Coastal Health. EES works collaboratively to implement a regional approach to low-carbon, climate-resilient and environmentally sustainable health systems through planning, design, procurement, construction and operations.

Acknowledgement: EES acknowledges the many consultants, internal subject matter experts and departments that have created, reviewed and provided feedback to the LCRES Guidelines. The LCRES Guidelines continue to be updated. The latest version is available at: **bcgreencare.ca/resource/guidelines/.**

For questions and support, please contact the EES team at info@bcgreencare.ca.

Purpose and Goals

The LCRES Guidelines' purpose is to enable implementation of low-carbon, climate-resilient and environmentally sustainable strategies as part of new construction and major renovations of acute, long-term care, and other healthcare facilities. Applying the LCRES Guidelines during the planning phases will produce relevant deliverables, requirements, design strategies and accountability mechanisms to be embedded into project documentation and contracts. This document is a resource for project managers, planners, architects, engineers, contractors, operators and other members of the project team.

The goal of the *LCRES Guidelines* is to support project teams to achieve the highest standard of human and environmental health through design and construction of new healthcare facilities.

Key references for the LCRES Guidelines include:

(i) The Ministry of Health Capital Health Policy Manual: Policy 11: Environmental Sustainability and LEED Gold Certification; Policy 12: Carbon Neutral and Climate Resilient Health Care Facilities; and Policy 14: The Use of Wood in Health Care Facilities (Appendix O);

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

(iii) Provincial *Climate Resilience Framework and Standards for Public Sector Buildings* (Appendix E) and *Climate Resilience Guidelines for BC Health Facility Planning and Design* (Appendix F),

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

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

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, Climate Resilience and Environmental Sustainability

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 Gold Certification; Policy 12: Carbon Neutral and Climate Resilient Health Facilities; and Policy 14: The Use of Wood in Health Care Facilities.

In addition, Fraser Health, 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 B).

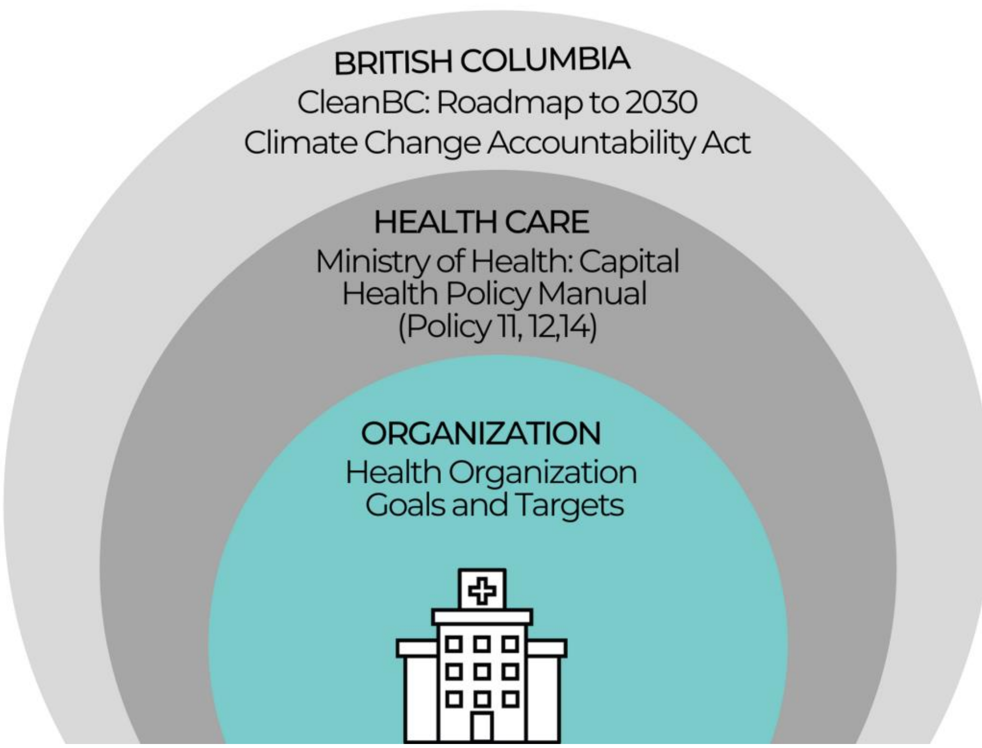

Figure 1 Low Carbon, Environmental Sustainability, and Climate Resilience requirements and guidance for BC health-care organizations

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.

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.

BC health authorities are committed to working to understand and manage risks associated with climate change, and developing strategies to adapt over time.[2]

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.

BC health organizations are committed to environmental sustainability to achieve the government's mandate and to benefit staff, patients and communities through improved environmental practices.[3]

Leadership in Energy and Environmental Design (LEED)

Achieving a Gold level of Certification through Leadership in Energy and Environmental Design (LEED) has been mandatory for many years. Recent updates to the Ministry of Health Capital Policy Manual make explicit that an equivalent standard can be utilized. This is understood to mean other environmental rating systems and/or certification systems can be pursued instead[4], including but not limited to ILFI[5] – Core Standard, Passive House, CaBGC[6] – Zero Carbon Building Standard – Design etc. See the LEED section for guidance on a LEED accreditation pathway.

See Appendix A for a Glossary of Terms

[2] Ministry of Health, Health Capital Policy Manual, Policy 12: Carbon Neutral and Climate Resilient Health Care Facilities

[3] Ministry of Health, Health Capital Policy Manual, Policy 12: Environmental Sustainability and LEED Gold Certification

[4] Note that approval is likely required in order to deviate from LEED Gold, which is the default approach

[5] International Living Future Institute (living-future.org)

[6] Canadian Building Green Council (cagbc.org)

When to Use the Guidelines

Project Planning

The *LCRES Guidelines,* together with the *Climate Resilience Guidelines for BC Health Facility Planning and Design,* should be used to inform high level master planning and site planning exercises. These guidelines are supported by the *LCRES Scope of Work* (see Appendix C for sample) to embed requirements and associated cost allocations within the Concept Plan and Business Plan.

Figure 2 highlights the key guidelines and components of the LCRES Scope of Work to inform the planning phase.

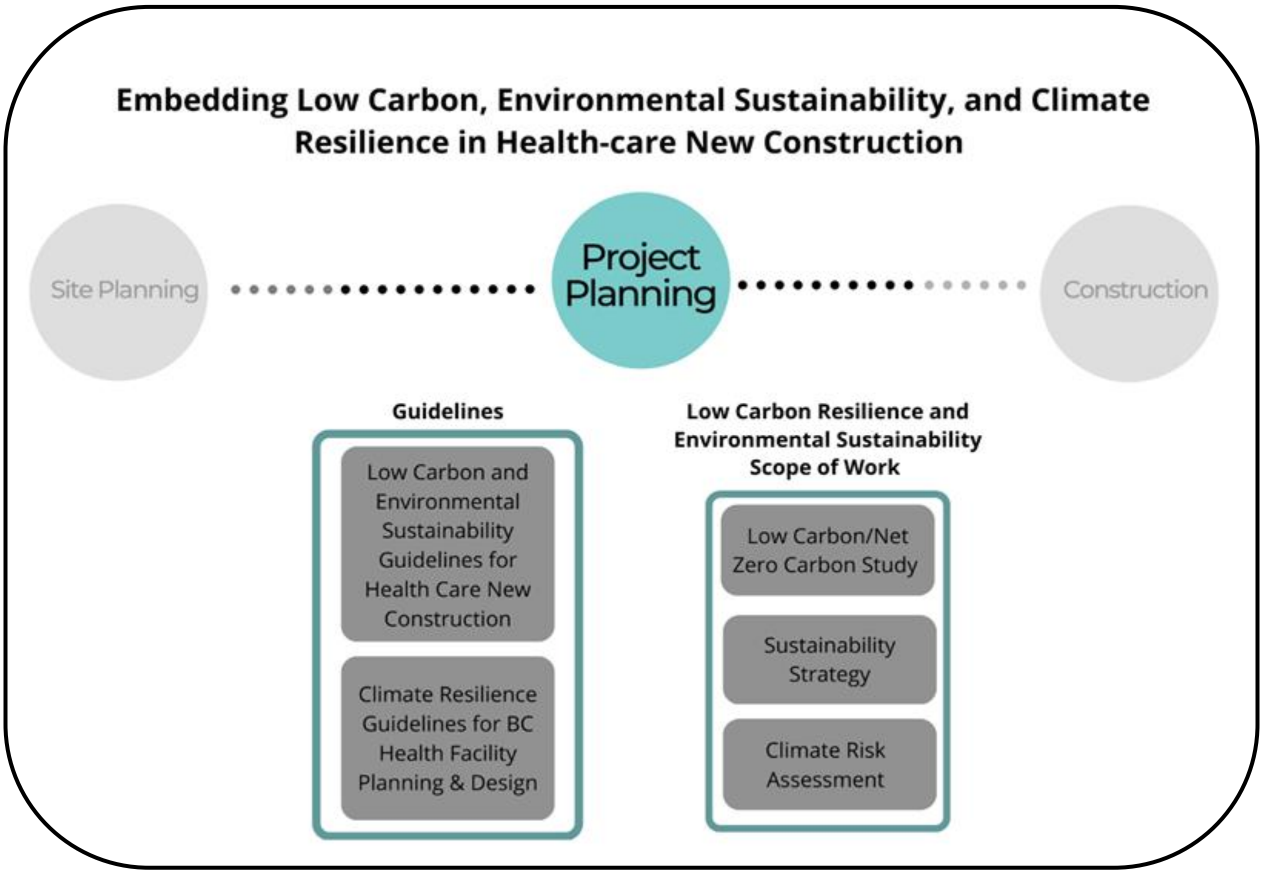

Figure 2 - Key LCRES documents to inform the Planning Phase

Design, Construction and Post-Occupancy

The guidelines continue to be a valuable resource through successive design iterations. They also cover key accountability processes to be followed during construction and post-occupancy to ensure requirements are realized in actual performance.

Project Delivery Model

This guideline is intended to be applicable to all projects regardless of the procurement strategy or project delivery model, and will need to be customized to each project.

Low Carbon

This section is focused on strategies to reduce building operational carbon emissions, that is, carbon emissions associated with the lifetime operation of the health-care facility. This is in contrast to embodied carbon emissions, the emission of greenhouse gases associated with the initial construction and periodic renewal of the facility. Embodied carbon emissions are addressed in the Environmental Sustainability section of this document.

The operation of an energy efficient and low carbon health-care facility will be enabled by implementation of the following interrelated elements:

- Performance targets
- Energy modelling
- Embodied Carbon
- Accountability mechanisms
- Technical design recommendations
- Commissioning

Refer to "Appendix D - Guidance for Low Carbon Accountability Mechanisms" for additional guidance on how to implement the above elements.

Performance Targets

Performance targets should be established during the earliest phase possible (ideally Business Plan) and will become part of the contractual requirements for design and construction. Project-specific targets should be developed through a collaboration between the health organization energy manager, energy modeller, mechanical designer, electrical designer, and other design team members as needed. Developing appropriate targets is a multifaceted process that should take into account relevant Federal, Provincial, and health organization targets and be informed by a combination of benchmarking (similar high performing facilities), end-use breakdown analysis, energy modelling, and energy/carbon/cost intensity analysis. It is recommended that the following targets be set to help balance the competing priorities of energy, carbon and operational cost:

- **Total energy target (MWh/year, or kWh/m2/year)**
  - Often developed as an Energy Use Intensity (EUI) target and can be converted to MWh as soon as the project floor area is well defined (+/- 10% accuracy)
- **Carbon target (tCO_2e/year, or $kgCO_2e$/m2/year)**
  - Developed based on the degree of carbon reduction that is deemed feasible for the

    - project, meeting or exceeding mandatory targets
    - Calculated from the predicted energy consumption for each utility (based on energy modelling) multiplied by the appropriate emission factors
    - Embodied carbon is currently addressed separately (see Embodied Carbon section)
- **Utility cost target ($/year, or $/m2/year)**
    - Calculate based on energy and carbon targets converted to cost using the agreed utility rates
- **Thermal energy demand target (MWh/year, or kWh/m2/year) [Optional[7]]**
    - Defined as the annual heating energy demand for space conditioning and conditioning of ventilation air that is output from any and all types of heating equipment
    - Calculated from Thermal Energy Demand Intensity (TEDI) target and converted to MWh

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

Energy Modelling

An energy model is required to evaluate design options, to support development of energy and carbon performance targets, and towards the end of the project to validate performance and secure incentives. An energy model should be developed at the Business Plan stage, or earlier if appropriate, in order to enable life cycle cost analysis of design options. The energy model will be updated to become increasingly detailed and accurate as the project progresses.

An Energy Model Report is produced with each major update to the energy model, in order to summarize the inputs, outputs (results), and analysis (for example, the extent to which targets have been met). Refer to Appendix G for requirements for Energy Model Reports and choice of simulation

[7] There are ongoing discussions to determine the value of having a TEDI target in addition to carbon targets in a health care context given high ventilation rates which dominate the thermal energy demand

engine, as well as guidance regarding inputs and assumptions. The purpose of the Energy Model Report changes over time; therefore, the content of the report will change, and typically should include the following:

- Summary of Inputs and Assumptions
  - Summary of various design parameters (see Appendix E for details)
  - Summary of various assumptions (for example related to plug loads)
  - Energy Conservation Measures (ECMs) evaluated
- Summary of Outputs, Analysis and Results
  - Predicted energy use, carbon emissions, and energy cost
  - Life cycle cost analysis (LCCA) of options (taking into account capital cost and operating cost)
  - Facility performance relative to the energy, carbon and energy cost targets
  - Peak demand (gas and electricity)
- Next Steps
  - Summary of next steps in the process including when the next update is scheduled

It is the responsibility of the Energy Modeller to ensure they are aware of all reporting requirements required to meet the requirements of both the CleanBC New Construction Program and FortisBC Commercial New Construction Program, including a final version of the energy model file.

Refer to "*Appendix D: Guidance on Low Carbon Accountability Mechanisms*" on use of energy modelling to support accountability mechanisms.

Embodied Carbon

See Embodied Carbon section in this document. Conduct an LCCA for ECMs (operational carbon emissions) and a Life Cycle Assessment (LCA) for material choices (embodied carbon), during the Business Case, to allow comparison of costs and benefits among all low carbon strategies.

Technical Design Recommendations

The recommendations below are expected to achieve a higher energy performance than what is mandated by BC Building Code or municipal bylaws. These recommendations are intended to build upon and complement health organization Technical Design Requirements, and should be taken into consideration, starting in the Business Plan phase in order to minimize cost impacts.

Mechanical Design Guidance

The building mechanical system design and operation should comply with the following thermal energy optimization principles:

- 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 if heat is being rejected from the facility (by heat rejection equipment or as exhaust / relief air) that can viably be reclaimed with passive or active systems, to meet space heating, ventilation, or domestic hot water pre-heat loads. For example:
    - Exhaust/relief air systems over 945 L/s (2,000 cfm) should be equipped with capability of recovering heat such that the leaving air temperature can be reduced to at least 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.
- To maximize total system efficiency:
    - Heating systems (closed loop) 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.
- 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, require a humidity range of 30% - 60%. Despite creating an energy penalty, recent research recommends

a higher humidity range of 40% - 60%, for occupant health benefits[8]. Specialized areas such as Operating Rooms, may have more stringent criteria as outlined in each health organizations' technical requirements Consideration for efficient, low carbon means of humidification is recommended.

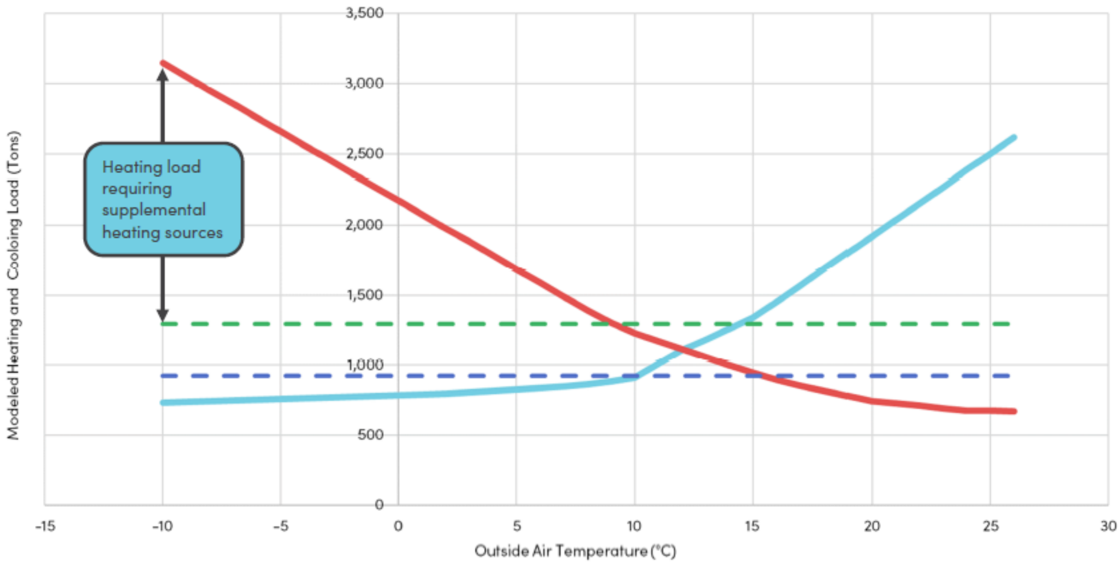

Figure 4 Model of thermal recovery. Heating (red) and cooling (light blue). Dashed lines indicate options for heat recovery load.

HVAC Design Recommendations

- All mechanical systems should be designed to 2050 climate projections and sized for optimal flexibility to 2080 climate projections.
- Displacement Ventilation should be considered as a means to simultaneously improve ventilation effectiveness and indoor environmental quality, and achieve energy and carbon savings.
- Where air handling units are designed to operate with mixed air during normal operation with the potential for 100% outside air, exhaust air heat reclaim systems should be sized to optimize efficiency at the higher outside air flow rates, where possible.
- 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.

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[8] https://www.nxtbook.com/nxtbooks/ashrae/ashraejournal_QVMNEO/index.php?startid=31#/p/30, Dr Stephanie Taylor, C. Michael Scofield, Patricia Graef, PE

- 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
  - Electric boilers and batteries
- 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 (RNG) 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% outdoor air and to sizing the heat recovery system accordingly 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 heating/cooling, with dedicated heating/cooling equipment providing the peak loads.
- Designs should consider thermal and/or electrical energy storage to increase the ability to use freely available thermal energy and/or to reduce peak electricity demand.
- Designs should integrate renewable energy sources, such as solar thermal, solar PV etc 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.
- The cost of approaching a Passive House Standard envelope performance should be assessed, by

taking into account capital savings that can be realized with a smaller central heating and cooling plant and distribution systems, and the co-benefits of thermal comfort and climate resilience.

- Passive House design strategies should be considered including:
  - Continuous insulation throughout the 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 (where appropriate).
  - Design of 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 precedence.
- Long-term trending of minimum 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.
- Explore alternative means of humidification without gas fired steam generation
- Explore alternatives to gas fired generation of steam for process steam loads
- Consider the 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 used as the minimum 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 main doors and low use areas where economics are favourable.

Accountability Mechanisms

Experience has demonstrated that establishing performance targets is not sufficient by itself to ensure that these targets are met during facility operation. An overall accountability structure has been developed and refined over the past decade to ensure effective processes, clear deliverables and critical roles and responsibilities are in place to support achievement of operational targets, as summarized in Appendix D: Guidance on Low Carbon Accountability Mechanisms.

Important elements of an effective accountability mechanism to achieve the project's energy and carbon targets are listed below. The specifics of each item needs to be customized to the project and are influenced greatly by the project delivery model.

- Energy modeller role (decide when to hire, qualifications, scope by project phase, etc.)
- Independent Energy Consultant (IEC) (decide when to hire, qualifications, scope by project phase, etc.)
- Measurement and Verification (M&V) plan, which is typically developed by the design team (with oversight from the IEC) and documented in an Energy Management Plan (EMP)
    - The M&V scope shall adhere to Option D (Whole Building Calibrated Simulation) Method 2 of *International Performance Measurement and Verification Protocol (IPMVP) Volume III*
- Reporting requirements (types of reporting by project phase)
- Financial mechanism (incentives to drive superior performance, penalties for non-compliance, and holdbacks)

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

Climate Resilience

The health organizations are committed to moving towards a climate-resilient health system. New and replacement health facility projects represent a key opportunity to understand risk and maximize resilience to changing climate conditions. This section summarizes key steps in considering climate risk and resilience in the planning and design phases. Additional details and instructions are available in the Provincial *Climate Resilience Framework and Standards for Public Sector Buildings* (Appendix E) and *Climate Resilience Guidelines for BC Health Facility Planning and Design* (Appendix F).

As prescribed in the Provincial *Climate Resilience Framework and Standards for Public Sector Buildings*, the following should be completed:

- Identify the building's criticality
- Conduct an exposure screen and identify potential impacts to the building
- Determine climate risks through a climate risk assessment
- Identify relevant minimum climate resilience requirements and any additional resilience strategies to be embedded in procurement document development
- Carry out additional climate risk studies if identified as necessary by a qualified professional

At a minimum, the above should be summarized in a report submitted to the health organization and the Climate Action Secretariat.

In addition, the following should be carried out as described in the *Climate Resilience Guidelines for BC Health Facility Planning and Design*:

- Carry out a resilient design review to identify and track design strategies that meet established climate resilience requirements
- Conduct a compliance audit to ensure that established climate resilience requirements are met

Environmental Sustainability

Sustainable 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 contribute to environmental and human health, the recommendations within each of the following areas should be considered for incorporation.

Biodiversity and Greening the Campus

Maintaining and restoring biodiversity is crucial for the health of our planet and its inhabitants. It is therefore essential to consider the impact of health facility new construction and major redevelopment projects on the local environment. By incorporating green space and sustainable design principles, these projects can contribute to the preservation and enhancement of biodiversity. Creating green spaces at our health facilities not only provides a welcoming and therapeutic environment for staff, patients, and visitors but also supports the flourishing of local ecosystems.

Through a collaborative study with the University of British Columbia Collaborative for Advanced Landscape Planning (CALP) and local governments, the health organizations have identified eight scalable evidence-based urban greening strategies to emphasize in project design, including:

1) Views from within
2) Plant entrances
3) Bring nature nearby
4) Retain the mature
5) Generate diversity
6) Create refuge
7) Connect experiences
8) Optimize green infrastructure

Incorporating green design and biodiversity at health facility campuses can be integrated with other project initiatives, such as landscape design, storm water management, environmental site assessments, environmental impact assessments, and invasive species management. By recognizing and acknowledging these interconnected relationships from the outset, project teams can maximize synergies and emphasize the co-benefits that arise.

Additional information is available on the BC GreenCare website at the following links:

- Green Design for Climate Resilience & Well-Being: A Better Practice Guide
- Climate Resilience & Well-Being through Neighbourhood-Scale Green Design

Embodied Carbon

Global warming impacts from greenhouse gases emitted during the extraction, manufacture, transportation, maintenance, and disposal or recycling of materials needed for construction can be a significant portion of a building's lifetime global warming impact (its 'carbon footprint') (Figure 5).

In order to measure and help reduce the embodied carbon, a Life Cycle Assessment (LCA) is required to be completed as part of the initial design, with updates to the LCA as described below. Follow guidance for conducting an LCA from National Research Council of Canada's "*National guidelines for whole building life cycle assessment*".

Business Plan

Conduct an LCA. Determine preliminary total embodied carbon and identify major contributors. Recommend design options to achieve a minimum 10% reduction in lifetime embodied carbon emissions as compared to the baseline building. Refer to Appendix I for guidance on establishing a baseline and LCA parameters.

Provide a detailed export of data to inform future LCAs that may be performed by others.

Compare the capital cost of embodied carbon reduction options against the capital cost of operational carbon reduction options (as shown by draft energy modelling results). This is to inform early decisions on the best strategies for overall lifetime carbon reduction ($/tonne eCO_2).

Design and Construction

Conduct an LCA as part of Schematic Design, to choose design options to reduce lifetime embodied carbon emissions by a minimum of 10%. Provide a final LCA report based on IFC (Issued For Construction) drawings.

LCA Scope

Details on the scope and parameters for the LCA are listed in Appendix I. These parameters are designed to ensure consistency in application across health-care facilities, in order to build a database of comparable data. The LCA parameters align in large part with local bylaw requirements or sustainability certifications. If an accreditation platform or bylaw requires different inputs, an additional LCA report will be completed for this purpose.

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

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 K)
- 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 health-care 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)

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 (e.g. 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 J) 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 J)

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

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 for current and future demand and influence future sustainable transportation behaviour.
- Account for existing and future transportation programs, and their implications on design.
- 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 L)

In order to support active transportation, designs should:

- Design bicycle storage facilities according to *Design Guidelines – Bicycle Parking Facilities* (Appendix L) 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 consider creation of dedicated parking spaces for carpool vehicles. See relevant guidance from municipalities[9].

Electric Vehicle Charging

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

Visitor and Employee 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.

[9] City of Vancouver document: TDM Admin Bulletin Schedule A (vancouver.ca)

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

Fleet Vehicle Charging

As public sector organizations, the BC 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 preparation for the electrification of health organization 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 visitor and employee parking/charging.
- Ensure designated parking locations are provided with energized outlets with the capacity for Level 2 charging (208/240V).

Ambulance and First Responders Charging

Designs should plan for future electrification of ambulance and first responder fleets. Installation of a Level 3 (480/277 V) "Fast Charging" Station, for exclusive use by fleets, will support topping up ambulance and first responder vehicles when they are required to respond to consecutive calls.

Ambulance electrification will require 100 amp capacity breakers and Level 2 charging stations. Designs should consider space and electrical requirements at hospital emergency room ambulance bays. For the latest requirements, consult with Logistics & Transportation Operations, BC Emergency Health Services.

First responder parking at hospitals should be developed in consultation with the first responder organizations to ensure their charging requirements are met while applying best practices.

Designing for the Future

All designs should accommodate future demand for electric vehicle charging. In order to ensure that facility sites are prepared 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)

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 H) with, but not limited to LEED, including:
  - End user water reductions
  - Water metering by system (potable, process, etc.)
  - Mechanical systems water reductions (for example no once-through cooling)
  - Water reuse
- Select faucet and sink designs, subject to health organization guidance, 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 plumbing installation design, construction, commissioning, operation and maintenance requirements.

Leadership in Energy and Environmental Design

In order to align with the Ministry of Health: Capital Health Policy Manual Policy 11, health-care facilities are required to achieve LEED Gold or equivalent certification. To enable LEED certification, if this path is chosen, a LEED v4 scorecard template can be found in Appendix N, 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 N

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 ompliance)	Should Investigate	Not Recommended		Low Carbon	Environmental Sustainability	Climate Resilience
28	**44**	**25**	**23**	**Project Total**	**Co-Benefits**		

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.

1. **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.
2. **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.
3. **Not Recommended**
   - Credits that are not required, however 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: Glossary of Terms

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

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 B: 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 C: Sample: Low Carbon Resilience and Environmental Sustainability Scope of Work for New Construction Business Planning

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

Appendix D: Guidance for Low Carbon Accountability Mechanisms

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

Appendix E: Provincial Climate Resilience Framework and Standards for Public Sector Buildings

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

Appendix F: Climate Resilience Guidelines for BC Health Facility Planning and Design

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

Appendix G: Energy Modelling Requirements

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

Appendix H: 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 I: Scope and Parameters for Life Cycle Assessment (LCA)

A Life Cycle Assessment (LCA) will follow these parameters:

Inclusions

- All envelope and structural elements (including parking structure)
- Footings and foundations
- Complete structural wall assemblies (from cladding to interior finishes, including basement)
- Structural floors and ceilings (not including finishes)
- Roof assemblies
- Stairs construction

Exclusions

- Excavation and other site development, partitions, building services (electrical, mechanical, fire detection, alarm systems, elevators, etc.), and surface parking lots.

Biogenic Carbon

'Biogenic Carbon' can be described as 'the carbon sequestered during the growth of biogenic materials (eg. timber, natural insulation etc.)'. It is a 'net positive' or even 'reduction' in terms of GHG emissions whilst the material is in use and the carbon is stored inside. Whether to include this 'credit' in a LCA is debated in the field. There are two important factors:

- Farming or harvesting practices. For example clear cut forests can have lower carbon sequestration in soils and fungi systems, lower biodiversity, lower water retention etc. These downsides, mean some believe timber should not be given the benefit of biogenic carbon credit. Sustainable farming or harvesting practices or certifications tend to minimise these downsides.
- End of Service Life Use. If the biogenic material is incinerated without GHG emissions capture or sent to landfill then the 'stored' carbon will be released into the atmosphere. This has some benefit in that some emissions have been captured and stored for a period of time however the lifetime net positives are negated. Mass timber wood from large buildings is typically reused in BC, indefinitely storing the carbon. Projects can increase the likelihood of reuse through designing for disassembly and deconstruction.

For the purpose of this LCA, biogenic carbon is required to be included in overall sums but also reported separately.

Setting a Baseline

The baseline and proposed buildings must be equivalent and use the same scope and parameters. The baseline components are decided on a case-by-case basis however the LEED v4.1 guidance for "Building Life Cycle Impact Reduction" credit should be used as the default baseline. If, for example, it is intended to have a mass timber building, then a mass timber building will be the baseline.

System Boundary

- System boundary is Module A1 to C4 (cradle to grave), and does not include Module B6 (operational energy).

- Report on Module D (Beyond the Building Life Cycle Stage) separately.
- In addition to calculating emissions with GWP100, also calculate with GWP20 data, to understand shorter term climate impact especially in consideration of refrigerant choices.
- Use GWP100 data to calculate the 10% reduction target.

Database

- The Life-Cycle Inventory (LCI) database must be ISO 14040, 14044 and 21930 compliant, and regionally specific if possible.

Impact Assessment Categories

Report on all 12 Impact Assessment categories, as defined by National Institute for Standard and Technology. Global warming, ozone depletion, acidification, smog, eutrophication, ecotoxicity, human health (non-cancer), human health (cancer), land use, water use, particulates, fossil fuel depletion, indoor air quality.

Service Life

- Use service life of 60 years for all LCA models.

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 J: Waste Management Space Design Guidelines

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

Appendix K: Chemicals of Concern: Construction Interiors

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

Appendix L: Bicycle Parking Design Guidelines

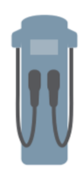
Refer to online Appendix at www.bcgreencare.ca/resource/guidelines

Appendix M: 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:

- 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 N: LEED v4 BD+C: Healthcare, Gold Scorecard Template

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

Appendix O: Ministry of Health Capital Policy Manual Chapters 11, 12 and 14

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