The University of British Columbia

Whole Systems Infrastructure Plan

Executive Summary

Okanagan Campus / May 2016

a place of mind

THE UNIVERSITY OF BRITISH COLUMBIA

ACKNOWLEDGEMENTS

The University respectfully acknowledges the traditions and customs of the Okanagan Nation and its people in whose territory the campus is situated. The Syilx (Okanagan) people have been here since time immemorial. In September 2005, the Okanagan Nation Alliance officially welcomed UBC to traditional Syilx (Okanagan Nation) territory in an official ceremony, Knaqs npi'lsmist, where UBC signed a Memorandum of Understanding with the Okanagan Nation.

As they have been stewards of this traditional territory since time immemorial, UBC works with the Okanagan Nation to ensure they are partners in the pursuit of planning at the Okanagan Campus.

FOREWORD

UBC Okanagan, a campus acquired by UBC in 2005, has moved quickly to advance sustainability practices despite the challenge of rapid growth. Since 2007, the campus has achieved a 40% reduction in GHG emissions per student despite a 91% increase in building space and an 81% increase in student enrollment. New LEED® certified buildings, a closed-loop aquifer geo-exchange district energy system, and a unique ecosystem supported by on-site stormwater management strategies have yielded early sustainability performance benefits. The campus is currently at a pivotal point to deepen our sustainability performance against the backdrop of potential impacts and opportunities, ranging from climate uncertainty to renewable resources.

The Whole Systems Infrastructure Plan (WSIP) was developed parallel to and in support of the UBC Okanagan Campus Plan (2015), which provides a foundation for campus growth and development over the next 20 years and beyond. One of the four overarching goals of the Campus Plan is an explicit call to deepen our approach to sustainability through whole systems thinking.

"Campus growth should be managed through a whole systems (environment, economic and social sustainability" Lens to achieve a net-positive impact on the wellbeing of the campus community and ecology."

Departing from the traditional system-by-system infrastructure planning approach, the whole systems approach views the entire campus as an integrated set of systems. The objectives of the WSIP are wide reaching – from mitigating future climate change risks by reducing energy and carbon emissions, to reducing operational and maintenance costs and limiting our exposure to future price volatility, to supporting technological innovation, and creating an opportunity for research and development. In doing so, the WSIP will contribute to the wellbeing of students, faculty and staff, improve productivity and performance, and make the campus a highly desirable place to learn, work and live.

Implementation

The WSIP's implementation plan addresses energy, carbon, water, landscape, ecology, biodiversity and engagement. The first (five year) phase of the WSIP's energy and carbon reduction actions has already commenced with the establishment of an MOU with FortisBC for Partners in Energy Efficiency and the development of a dedicated Energy Team. This first phase is focused on Demand Side Management (DSM) for existing and new buildings, changing user behaviors and optimizing infrastructure performance. Funded through existing programs and incentive financing and rebates, these DSM actions are expected to reduce utility costs, while at the same time reducing GHG emissions from existing buildings. In parallel, the campus has initiated key policy updates

to inform comprehensive green building design guidelines that respond to environmental, social and economic sustainability performance imperatives; as well as the establishment of an Integrated Rainwater Management Plan to advance the WSIP's ecology and biodiversity imperatives.

For the long-term, the Okanagan campus is uniquely positioned to expand its existing district energy systems in order to support future growth while reducing GHG emissions. This approach leverages the significant investment in the existing district energy system and ensures that these investments are protected and enhanced. The WSIP recommends GHG emission reduction targets for the campus which will be evaluated and presented for Board approval. To ensure long term economic viability, UBC will balance the return on WSIP investments and targets against future campus growth, commodity and carbon pricing, renewable energy options and technology.

UBC is committed to being a leader in sustainability and the Whole Systems Infrastructure Plan is the Okanagan campus' path to an environmentally, socially and economically sustainable future. It is exciting to see that the collaborative and rigorous process of developing the WSIP has created alignment and capacity across the many UBC operational and administrative units on both campuses, including those responsible for the stewardship of the UBC Okanagan campus. We are committed, through this Plan, to ensure that these investments are protected and enhanced now and into the future.

Sincerely,

Deborah Buszard, Deputy Vice-Chancellor and Principal

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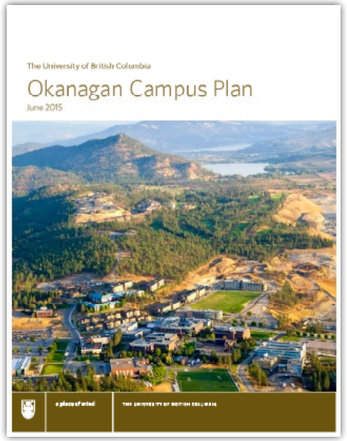
EXECUTIVE SUMMARY

The UBC Okanagan Campus Plan asserts that "Campus growth should be managed through a whole systems (environment, economic and social sustainability) lens to achieve a net-positive impact on the well-being of the campus community and ecology." The UBC Okanagan Whole Systems Infrastructure Plan (2015) establishes a roadmap to help achieve this vision across existing and future built and naturalized campus environments, in order to support the academic mission and the overall wellbeing of the campus.

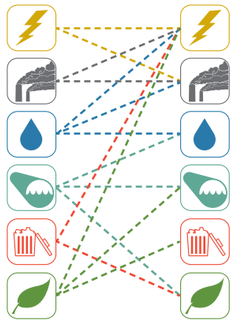


UBC is an established leader in climate action and sustainability. UBC's Okanagan Campus in particular, is at a critical point in its development, having more than doubled student enrolment and nearly tripled campus floor space since 2005. The campus has established a strong sustainability foundation to build on as it plans for the next phase of its development. New LEED® certified facilities, a closed-loop aquifer geo-exchange district energy system, and a thriving ecosystem supported by on-site storm water strategies have yielded early sustainability performance benefits as well as opportunities for continuous improvement. The campus is now at a pivotal point for exploring opportunities to deepen its sustainability performance and establish a framework for infrastructure development required to support the future growth of its campus over the next 20 years and beyond.

The next phase of the campus' physical planning and design is defined by *The UBC Okanagan Campus Plan (2015)*, which guides and manages campus growth, while supporting the University's strategic plan and academic mission. It defines where academic and research activities, student housing, campus services and infrastructure will be accommodated over the next 20 years and beyond. Among its four planning principles, the *Campus Plan* asserts that, "Campus growth should be managed through a whole systems (environment, economic and social sustainability) lens to achieve a net-positive impact on the well-being of the campus community and ecology." It articulates UBC Okanagan's 2050 *Whole Systems Infrastructure Plan* Goals:

- Goal #1: Achieve a net positive performance in operational energy and carbon
- Goal #2: Implement a framework that supports low embodied carbon in future development
- Goal #3: Optimize water quality, supply and security
- Goal #4: 100% diversion of stormwater from municipal systems
- Goal #5: Strive towards full waste recovery/reuse
- Goal #6: Enhance and/or restore the site's ecology

Potential synergies between performance areas.



What is a Whole Systems Infrastructure Plan?

The *Whole Systems Infrastructure Plan* (*Plan*) takes a fundamentally different approach away from traditional engineered infrastructure systems. Whole systems infrastructure planning is underpinned by a multi-disciplinary and integrated approach that identifies synergies across infrastructure, the built environment and natural systems. Working through an integrative design process, the *Plan* sets forward a roadmap to achieve a highly sustainable campus that leverages components of buildings, landscape, public realm and infrastructure that work together in creating a whole that is greater than the sum of its parts. The *Plan* identifies a number of strategic opportunities through upcoming capital projects to deliver incremental elements of the *Plan* with the objectives of reducing long term operational costs, reducing maintenance, and improving performance.

Arising from, and informed by the *Campus Plan* development process, the *Plan* has been established as a companion document to the *Campus Plan* and should be used in relation to the *Campus Plan*. The *Plan* has been established to help achieve the campus' whole systems vision and goals, against the backdrop of potential future campus growth required to support its academic mission; climate impacts; and utility rate uncertainty.

The *Plan* establishes a long-term roadmap to achieve campus sustainability performance across built and natural environments to 2030 and beyond, and proposes environmental sustainability performance targets and a 5-year implementation plan. It challenges the campus to think differently about operational practices, future infrastructure investments and long-term financial decisions. Most importantly, it substantiates the imperative of acting now given the cost of inaction, which would see a steady rise in resource consumption and associated costs to the campus over time.

The *Plan* is intended to:

1. Enable the campus to understand and respond to potential future growth and climate risks, including the management of energy, carbon, water and waste, and associated costs; and protect and enhance biodiversity and ecological assets on campus.
2. Guide future campus sustainability priorities and actions, by identifying and prioritizing cost saving measures for implementation such as changes in existing operational practices and policies as well as specific initiatives that are supported by a sound business case and return on investment.
3. Provide a framework to engage the campus community and academy in the *Plan*'s implementation, through stewardship activities, student involvement and campus as a living laboratory opportunities.
4. Exemplify UBC's sustainability leadership by responding to its sustainability aspirations in *Place and Promise: The UBC Plan*, *Aspire, The UBC Climate Action Plan*, and regenerative sustainability in the *UBC 20 Year Sustainability Strategy (2014)*.

Developed to inform the campus' internal priorities and actions, the *Plan*'s implementation will require engagement and action on the part of many UBC stakeholders across both campuses at the technical, organizational and behavioral levels to ensure the *Plan*'s outcomes are achieved.

1. **Technological:** assess and implement the technical performance changes required to improve the performance of existing buildings, infrastructure, landscaping projects, new construction and future development, as recommended in the *Plan*.
2. **Organizational:** identify institutional changes and opportunities (i.e., policy, departmental, governance, student engagement and academic research) and funding required to implement the *Plan*'s recommendations.
3. **Behavioral:** establish engagement and awareness initiatives, reaching all faculty, staff and students that encourage actions to conserve resources across all performance areas. In particular, to facilitate a fundamental shift in how campus stakeholders regard the use of resources and assets on campus and therefore deepen and maintain the impact of technological changes over time.

RATIONALE FOR THE PLAN

The campus is comprised of buildings and infrastructure that contribute to its long term operational costs. The *Plan* provides multiple benefits and opportunities to reduce exposure to costs while creating a more resilient campus.

Operating costs are required to support six academic legacy buildings built between 1992 and 2001, five new academic buildings built 2008 onwards, and 18 residential buildings built between 1992 and 2010. Campus infrastructure systems include the Geo-exchange District Energy System (DES) used for heating and cooling by academic buildings; the Central Heating Plant (CHP), used for heating of legacy academic buildings; a natural gas distribution system; a power distribution system; a potable water distribution system; a sewage wastewater conveyance system; stormwater infrastructure and natural ecosystems.

A set of working assumptions detailed in the *Plan* related to potential future student growth and campus development, projected climate impacts and UBC's sustainability aspirations underpin the roadmap's recommendations. Building and infrastructure system performance have been assessed by the project's consulting team to understand, analyse and model:

- Campus operational costs, challenges and cost savings opportunities;
- Impact of business as usual on energy, carbon and water consumption and costs;
- Potential future infrastructure development that aligns with the *UBC Okanagan Campus Plan*'s intent; and
- Climate related risks, such as the potential increase in cooling demand and associated utility costs; as well as potential impacts to social and environmental benefits, such as loss of ecosystems and biodiversity.

Campus energy costs are substantive and growing. $2.7 million was spent by the campus for electricity and natural gas in Fiscal 13/14, up by 5% from the previous year. Electricity accounted for 65% of the overall campus energy consumption, while natural gas accounted for 35%. Electricity accounted for 80% of the overall energy cost per year, while natural gas accounted for 20%. However, natural gas also accounted for 96% of the campus' overall carbon emissions and offset liability. $176,971 was spent on carbon taxes, comprised of a $30.00 per tonne carbon dioxide equivalent emitted (CO_{2e}) tax on the purchase of natural gas, and a $25.00 per tCO_2 for the burning of natural gas to meet legislated carbon emissions offset requirements.

Under a business as usual scenario, normalised for campus development, energy price and weather; utility costs will continue to increase at an average of 1–2% per year. This is due to operational efficiency losses from building equipment and infrastructure as systems age; changes in how the campus utilizes space such as

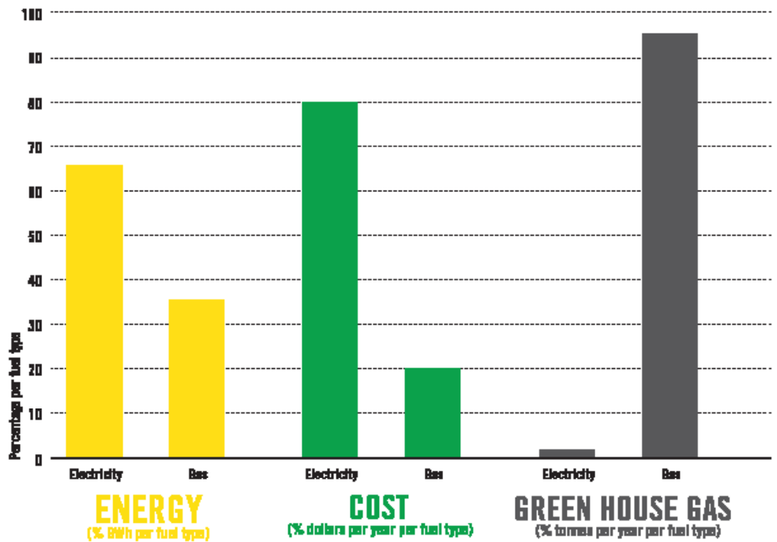


FIGURE 1: UBCO 2013 ENERGY—COST—GREENHOUSE GAS PROFILE

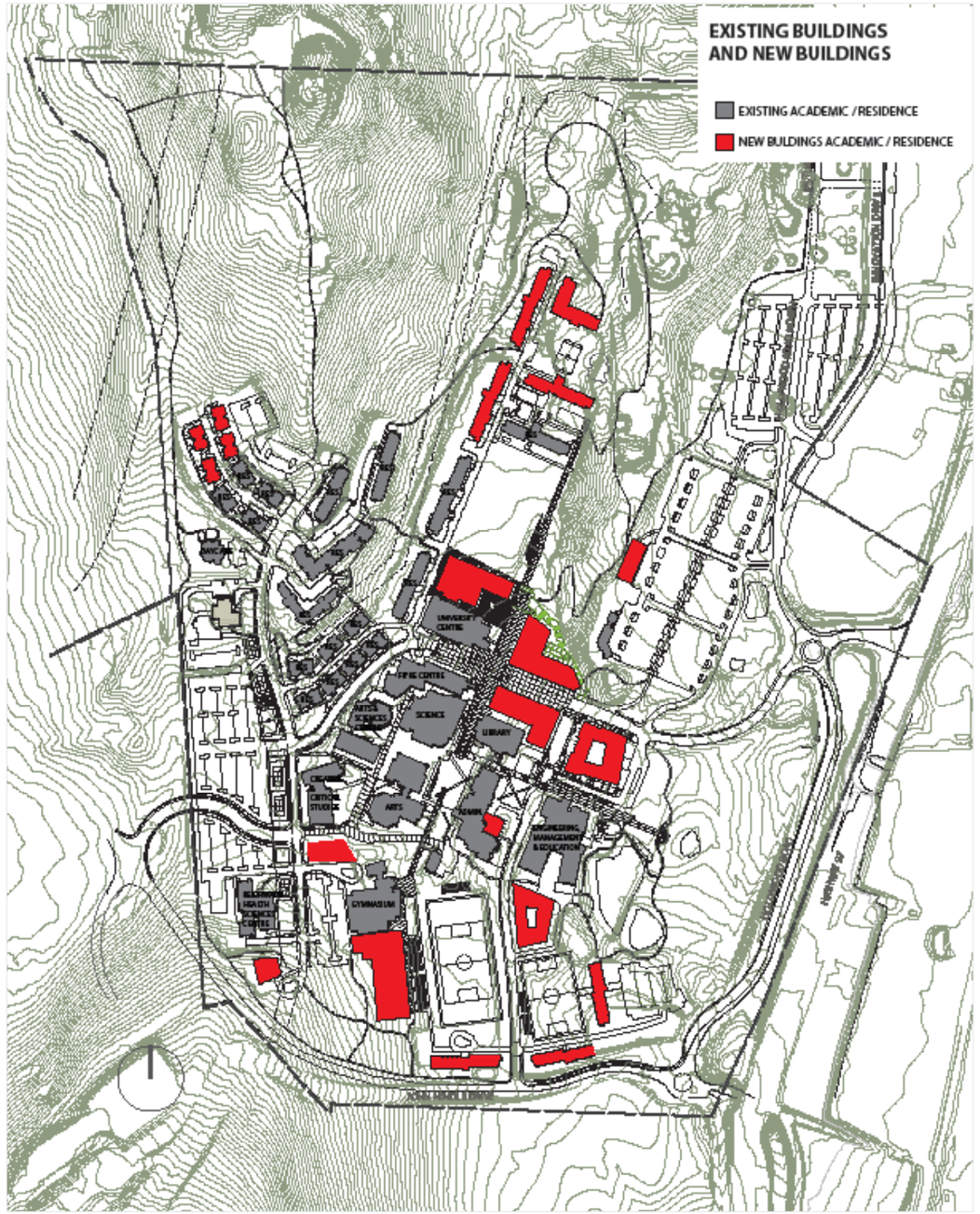
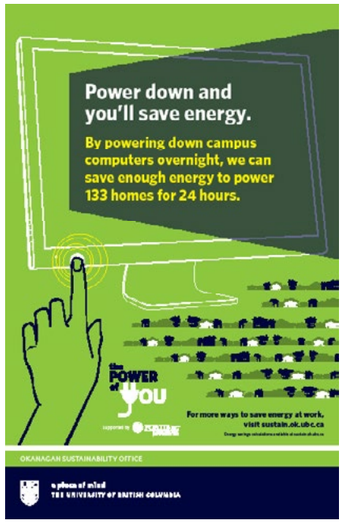


FIGURE 2: CAMPUS PLAN OF EXISTING BUILDINGS AND UBCO'S CAMPUS PLAN (2015) GROWTH PROJECTED FOR 2030

the addition of new research equipment and energy-intensive labs; increased use of campus facilities over all four seasons; and losses of potable water in campus distribution systems. Utility costs will increase due to campus development and utility rate changes, and climate impacts will also have an effect as shown in the *Plan*. In addition there is a risk of incremental loss of ecosystem services and biodiversity over time, through pressures from climate change and campus development.

The *Plan* identifies opportunities to improve campus sustainability performance when replacing end of life equipment/systems, which will reduce energy and water consumption and save costs. Buildings have opportunities to reduce energy use during unoccupied times, recover waste heat that is otherwise lost to the atmosphere, and improve performance through commissioning to align building performance with design intent. The district energy system contributes to lower gas consumption and carbon emissions, but is limited in capacity and operating temperatures and would benefit from optimization that could ultimately reduce future capacity needs, driving down demand and costs. As new civil and capital projects arise, opportunities exist to shift infrastructure from distributed to centralized systems; integrate sustainable landscape practices; incorporate site-specific storm water management practices and apply future technologies to achieve multiple benefits today and in preparation for the future. Opportunities exist to engage students and faculty to research and the development and implementation of projects to the benefit of campus operations and in support of the University's overarching academic mission.



In the process of identifying opportunities for improvement, it has also been demonstrated by the Okanagan campus that investment in energy conservation yields results. Energy conservation measures implemented across five legacy academic facilities through the UBC Okanagan/FortisBC Building Optimization Program have saved the campus over $150,000 in ongoing annual utility costs and which paid for the original investment in less than a year (equivalent to more than a 140% return on investment). This was complemented by the engagement of over 1,500 building occupants and student residents in a variety of energy conservation behavior change initiatives to save energy. During this timeframe reported use of energy conservation tools provided through the campus' Power of You Program increased from 15% to 53%; total campus utility costs decreased by over $200,000 and building energy-related carbon emissions decreased by 9 percent.

Aside from direct financial benefits, a growing body of research, endorsed by the US and Canadian Green Building Councils and the US Department of Energy, among others, supports that sustainable buildings improve occupant health and wellbeing. Healthy buildings promote the wellbeing of students, faculty and staff and improve productivity and performance, making the campus a desirable place to work, live and learn.

A summary of the roadmap is provided below, supported by a detailed overview of existing conditions, opportunities, analyses and recommendations contained in the *Plan*.

SUMMARY OF RECOMMENDED MEASURES

The roadmap defines recommendations on how the campus can in the context of continued growth:

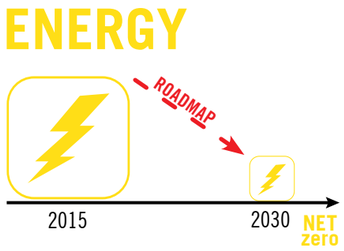
- Achieve a proposed 64% potable water use reduction by 2030 as compared to business as usual (BAU);
- Manage 100% of stormwater on-site;
- Use equal or less electricity;
- Use equal or less heating energy;
- Provide an ecologically rich and diverse campus environment; and
- Achieve a proposed 46% carbon reduction for campus operations compared to 2007 baselines (79% compared to BAU), and within range of attaining carbon neutrality through off-site partnerships.

The *Plan* recommends a broad range of measures for energy and carbon, water, stormwater, and biodiversity areas that are founded on detailed energy and economic modelling analyses that consider potential campus growth projections and climate impacts. Outlined below is a high level overview of the 5-year measures and long term directions articulated in the *Plan* , along with key integration points between performance areas. It should be noted that multiple synergies exist beyond the individual examples illustrated in the sections below.

TABLE 1: PROPOSED PERFORMANCE METRICS

	METRIC	CURRENT PRACTICE 2013	2030 BAU	2030 PROPOSED	% CHANGE OVER BAU 2020	% CHANGE OVER BAU 2025	% CHANGE OVER BAU 2030
Energy	kWh/m^2	334	220	129	-35%	-40%	-41%
GHG	tonnes/yr	3,317	5,591	1,177	-33%	-73%	-79%
GHG compared to 2007 baseline	tonnes/yr	2,186	5,591	1,177	+30%	-48%	-46%
Water	m^3/m^2/year	1.3	1.1	0.4	-29%	-40%	-64%
Waste to landfill	tonnes/yr	931	1,978	453	-	-	-51%
Stormwater	% leaving site	0%	0%	0%	0%	0%	0%
Biodiversity	Ha of habitat	not specified	0%	+15%	+5%	+10%	+15%

Table 1 provides proposed performance metrics detailed in the Plan's recommendations and overall aspiration. The business as usual approach (BAU) assumes that the BC Building energy code changes will result in lower building energy use intensity (EUI) in the future. Achieving the reduction in future building energy use will require UBC's investment in an improved commissioning process and a building re-commissioning program.



ENERGY AND CARBON

Goal 1 | Achieve a net positive performance in operational energy and carbon

5-Year Priority Actions

1. Establish an energy team. The campus has been implementing energy conservation projects with limited capacity and is at a stage where it requires dedicated resources in order to achieve continued and deeper implementation of energy conservation measures, energy planning, and continuous commissioning for improved performance and cost savings. A key priority in the first year of the *Plan*'s implementation will be to establish a dedicated energy management team to develop a campus energy and water management plan and to develop, implement and, monitor energy, carbon and water reduction measures. True to the whole systems approach, the energy team will not work in isolation but rather will work collaboratively as part of the technical team spanning both UBC's campuses, responsible for the implementation of priority measures recommended by the *Plan*.

2. Create an internal revolving fund. The campus has demonstrated positive returns on investment for energy conservation projects it has implemented. The proposed use of utility savings from energy conservation measures are intended to be reinvested toward deeper energy and carbon reduction projects as well as future infrastructure investments that improve the operational efficiency and reliability of systems that support the academic and research mission.

3. Establish a mechanism to monitor and verify energy and water savings that accrue to the campus utility budget, from capital projects and re-commissioning initiatives (the 'adjusted baseline utility model'). This is required in order to track savings from implemented measures and repay associated loans from the revolving fund.

4. Develop and implement energy and water conservation measures to achieve 5-year plan targets, reduce energy consumption of district energy systems and make capacity available for future growth, as detailed in the *Plan*.

5. Develop a Campus Wide Behavior Change Engagement Strategy to promote and support campus awareness for resource conservation and demand side management (DSM) strategies required for whole systems plan implementation.

6. Establish a process for developing the Owners Project Requirements (programme, indoor environmental conditions, priority technical guidelines, and sustainability targets) and reviewing quality assurance documents (e.g. commissioning plan, basis of design, monitoring and verification plan, monitoring based commissioning plan) for all major construction projects.

7. Update relevant policies. Update Design Guidelines, Technical Guidelines and Project Design Briefs, LEED v4 Implementation Guide, with guidance for energy performance of new construction, energy efficient systems and embodied carbon.

8. Pilot and plan for the integration of renewable energy technologies (i.e., solar PV) as the business case becomes more viable.

9. Initiate student research and projects to help inform larger infrastructure feasibility work required—currently underway.

5-Year Priority Actions—Infrastructure

1. Optimize performance of the district energy system (DES) and continue to connect to academic buildings for heat sharing and cooling. A study to evaluate the performance of the DES during heating, cooling and sharing seasons is currently underway as a direct result of this planning process. A servicing plan for future academic buildings will be required.

2. Expand the Central Heating Plant (CHP) to residential buildings and academic buildings. A detailed feasibility study (and servicing plan) is required to confirm the viability of CHP expansion to service all new and existing academic and Student Housing and Hospitality Services (SHHS) buildings and to establish a fixed and variable utility rate for SHHS.

3. Convert the CHP to biomass (or other renewable). A detailed feasibility study is required to determine the business case and optimal timing of the CHP conversion to renewable energy. A student engineering capstone project is currently underway to help inform this.

4. Monitor Key Performance Indicators (KPIs) for introduction of solar PV and solar ready buildings

5. Pilot solar PV/solar ready and monitor feasibility of larger scale implementation.

6. Evaluate the partnership opportunities to access off-site renewable energy sources (e.g. Renewable Natural Gas)—currently underway.

Long Term Directions

1. Expand CHP and DES piping systems as the campus constructs new academic and residential buildings.

2. Expand CHP to existing buildings as their natural gas boilers reach end of life.

> "Save electricity costs to fund gas and GHG emissions reduction opportunities."

3. Switch to renewable fuel sources to serve academic and residential buildings.
4. Install solar photovoltaic systems on new academic buildings as the declining costs of solar technologies create a financially viable renewable energy source in British Columbia.
5. Develop off-site partnerships for sourcing renewable energy and realizing value of excess energy capacity.

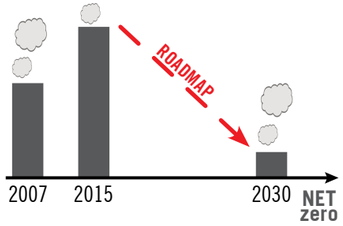
Potential Synergies or Points of Integration

- Synergies between energy and waste performance result from the opportunity to use biomass as a renewable fuel source for the campus heating system.
- Integration of recommended energy conservation measures, policies and practices into upcoming capital and planning projects.

Waste to Energy	BIODIVERSITY	WATER	STORMWATER	ENERGY	WASTE

It should be noted that synergies exist beyond the individual examples provided through the graphic.

CARBON



Goal 2 | Implement a framework that supports low embodied carbon in future development

Embodied carbon is defined as the amount of carbon dioxide emitted from the components used in buildings, from the emissions produced during the extraction of raw materials (cradle), to manufacturing (gate), transportation and installation, and finally end of life (grave).

The *UBC Climate Action Plan* includes a reference to tracking embodied energy associated with new construction, existing buildings and infrastructure. While reporting these emissions is not currently a legislated requirement, they are part of an organization's total carbon footprint, and account for the carbon emissions required to construct a building. The UBC Vancouver campus voluntarily monitors and reports on these emissions. UBC's Okanagan campus has the opportunity to develop an embodied carbon framework to:

- Understand the quantity of embodied energy/carbon in materials given the local context;
- Evaluate, monitor and track the embodied energy/carbon content over time, similar to a building's operational energy;
- Establish realistic targets and metrics for the University on per building basis or as a whole; and
- Identify new opportunities for reducing embodied carbon that can be supported by the business case.

5-Year Priority Actions

1. Set up the program and start research for development of strategic Embodied Carbon Framework.
2. Update *UBC Okanagan Campus Design Guidelines* to reflect the aspiration and mandate for new buildings and upgrades of existing buildings to evaluate and understand the embodied energy and carbon content of campus projects over time.
3. Establish guidelines and methodology for calculating embodied carbon with supporting toolkits and calculators.

Long Term Directions

1. Define performance metrics and targets for embodied carbon.
2. Establish an embodied carbon framework to achieve targets for reduced embodied carbon, materials and impacts through the design process for new construction and upgrades to existing buildings.

Potential Synergies or Points of Integration

- Carbon and Energy with Ecological Landscape and Biodiversity—Promote regenerative development by considering building materials' effects on ecosystems in a diverse selection of impact categories and embodied carbon as part of life-cycle analysis (LCA) toward UBC policy for embodied carbon.

Embodied Carbon Framework	BIODIVERSITY	WATER	STORMWATER	ENERGY	WASTE

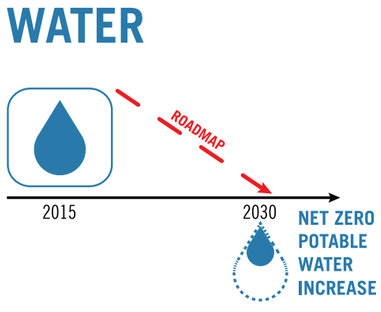
It should be noted that synergies exist beyond the individual examples provided through the graphic.

WATER

Goal 3 | Optimize water quality, supply and security

It will be important to consider how water conservation and reuse measures, along with programs to support water conservation-based behavior can be implemented to prepare the campus for future potential water shortages. Many jurisdictions, including BC, have introduced building code and policy changes that permit the re-use of reclaimed water for non-potable uses in buildings, such as toilet flushing. Non-potable water is carried by conventional water pipes that are painted a purple color.

Although UBC's Okanagan campus may be a moderate consumer of water in the broader region, this long-term imperative for the region will need to be monitored by the campus and factored into its strategic planning and decision making processes to position itself a regional leader in this area.



5-Year Priority Actions

1. Meter, measure, and monitor potable water usage on campus. The campus lacks automated building level water meters or separate metering of irrigation and is therefore unable to measure the break-down between end uses on campus in order to implement and measure the impact of water conservation measures or to determine leakage rates/ locations. The key priority for the campus will be to establish a water monitoring strategy to develop an accurate water use baseline through the implementation of a water audit program and installation of water meters in all existing and new buildings.
2. Develop a long term water management plan for the campus that establishes policy for auditing, monitoring and tracking overall water performance.
3. Implement water conservation-based measures that have an acceptable payback and target pressure reducing valves, upgrade buildings with more efficient water fixtures as part of cyclical maintenance, and continue to phase in drip irrigation systems.
4. Update *Design Guidelines*, *Technical Guidelines*, and *UBC LEED v4 Implementation Guide* for expected water performance of new construction and existing building upgrades.
5. Ensure that Project Design Briefs for new construction projects clearly articulate the aspiration and mandate for new buildings relative to the sustainability targets and long-term vision of water quality, supply and security. In particular, the installation of water meters, the modification of PRV settings, the installation of high efficiency fixtures, and the inclusion of biodiversity strategies for landscaping and use of water efficient irrigation systems.
6. Expand Campus Wide Behaviour Change Engagement Strategy to promote and support campus water resource conservation and DSM strategies required for whole systems plan implementation
7. Monitor KPIs for introduction of purple pipe ready policy for buildings and infrastructure and introduction of water re-use systems on building and campus scale.
8. Pilot purple pipe installation in new construction and retrofit projects to help determine incremental cost and viability of preparing the campus for an on-site water treatment facility.
9. Establish a water utility rate premium over base line water rates that helps fund water conservation measures and finance purple pipe.

Long Term Directions

1. When supported by the business case, phase in purple pipe distribution for reclaimed water. Capitalize on opportunities when DES and CHP expansion trenching occurs on campus in order to minimize site disturbance, maximize construction cost efficiency of infrastructure, and enable buildings to be ready for when the reclaimed water system is activated.
2. As a business case becomes more viable, phase in an on-site water reuse system to prepare the campus for long-term water scarcity and future escalation in water rates.

Potential Synergies or Points of Integration

- Synergies between energy and water performance result from operating pressure reduction adjustments, high efficiency fixtures, switch to drip irrigation and eventual non-potable supply, and hot water heat recovery.
- Integration of recommended water conservation measures, policies and practices along-side energy measures into upcoming capital and planning projects.

WCM 1: Operating Pressure Reduction (Adjust PRV's)	BIODIVERSITY	WATER	STORMWATER	ENERGY	WASTE

It should be noted that synergies exist beyond the individual examples provided through the graphic.

STORMWATER

Goal 4 | 100% diversion of stormwater

Currently, the campus maintains and manages all of its stormwater on-site. The storm pipe network and overland flow routes are designed to convey water within 12 major catchment areas. There are several storage ponds, as well as dry-wells, infiltration ditches, and a stormwater-fed wetland that has become an important ecological habitat. There are some areas that discharge runoff to off-site ditches and drainage areas.

5-Year Priority Actions

1. Collect and filter stormwater to an enhanced and expanded wetland network;
2. Where soil conditions and space permit on campus, infiltrate runoff from buildings and impervious surfaces in the campus core;
3. Implement specific stormwater improvements relative to the *Stormwater Management Plan (2011)* by placing a higher priority on using LID stormwater management methods where site conditions are suitable; and,

4. Update the stormwater management plan to reflect the *2015 Campus Plan* and incorporate LID strategies and include a geo-technical soils analysis to inform infiltration and other storm water management strategies.

Long Term Directions

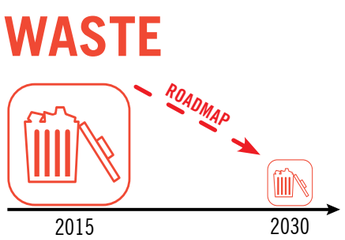
1. Integrate LID strategies that will enable the campus continue to divert 100% of stormwater from municipal systems between now and 2030.

Potential Synergies or Points of Integration

- Closely linked with these priority actions is the approach for enhancing and restoring biodiversity functions on campus.
- Integration of recommended measures, policies and practices into upcoming capital and planning projects

Stormwater Measure 1 Collect and filter stormwater to enhance wetlands	BIODIVERSITY	WATER	STORMWATER	ENERGY	WASTE

It should be noted that synergies exist beyond the individual examples provided through the graphic.



WASTE

Goal 5 | Strive towards full waste recovery/reuse

While out of scope for this planning study, energy production, energy cost and GHG savings of waste to energy systems were considered. It is recommended that a combination of anaerobic digestion and composting should be considered at the campus as part of the long term plan as this could be part of the campus as a "Living Lab" education for students. The implementation of the anaerobic digestion and composting process will also reduce the amount of waste going to the landfill where this waste will not be a producer of landfill gas. The operational metric of tonnes/FTE/yr to landfill would then be improved.

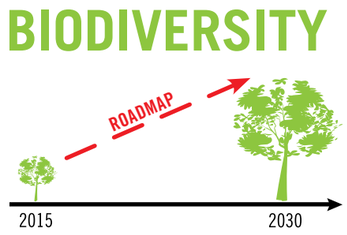
In addition, the Glenmore Landfill is located right on the west side of Okanagan campus and will soon have immediate access through the John Hindle Road connection. There are 300 tonnes of waste received by the landfill every day, and this amount is increasing every year. The Glenmore Landfill has been collecting landfill gas since 2005 and currently have a small micro turbine for electricity generation. It is understood that the Landfill has signed a 15 year "Landfill Gas Purchase Agreement" with FortisBC and that FortisBC is to buy raw gas and finance, design, build and operate a conversion facility to upgrade the gas to pipeline natural gas quality. There are potential opportunities to develop off-site partnerships between the University and the City of Kelowna Landfill for renewable natural gas or waste to energy campus as a living laboratory project.

5-Year Priority Actions

1. Continue to scope waste heat recovery opportunities for the DES;
2. Continue organic food waste composting program; and
3. Expand Campus Wide Behaviour Change Engagement Strategy to promote and support campus waste behaviour change, with a particular emphasis on resource conservation and DSM strategies required for whole systems plan implementation developing a waste separation and collection strategy for the student residences.

Long Term Directions

1. Consider the viability of a combination of anaerobic digestion and composting as part of the long-term plan, potentially as part of the Campus as a Living Laboratory initiative.



ECOLOGICAL LANDSCAPE AND BIODIVERSITY

Goal 6 | Enhance and/or restore the ecology

Ecosystems play a vital role in providing a range of services in terms of supporting soil formation, storm water mitigation, providing fresh water and habitat, regulating climate, carbon sequestration, enhancing air quality, and providing education and recreational value. Biodiversity is also a fundamental part of a well-functioning ecosystem. The *Whole Systems Infrastructure Plan* outlines a vision for providing an ecologically rich and diverse campus environment and will provide additional cultural, aesthetic, and recreational value to the broader community.

5-Year Priority Actions

1. Update the UBCO Design Guidelines to include:
   - Integration of natural systems into new construction and new and existing landscape projects;
   - Avoid incremental loss of natural areas including woodlands and indigenous grasslands during any future campus expansion; and
   - Tree planting in and adjacent to parking areas to provide summer shading and reduce urban heat island effect.
2. Ensure Project Design Briefs for new capital projects include:
   - performance requirements to use low impact development (LID) methods;
   - requirements to maximize biodiversity in landscaping; and
   - consider, on a project-by-project basis, green-roof feasibility (especially along ecological corridors and where site-lines to roof areas are visible).
3. Integrate natural systems into existing and future landscape projects as opportunities arise as a matter of best practices.
4. Expand campus-wide behavior change engagement strategy to include an education, awareness and outreach program that communicates

the measures and benefits of the biodiversity plan and work with non-governmental organization establish a stewardship group that helps maintain nature trails and conducts interpretive walks.

5. Update the Campus' Wildfire Management Plan.

Long Term Directions

1. Create guidelines to ensure protection of existing ecological features during campus development;
2. Create a compact campus core that integrates buildings and landscapes that capitalize on natural systems;
3. Collect and filter stormwater to enhance an expanded wetland network on campus;
4. Incorporate native plants into the campus landscape; and
5. Enhance the use of the campus as a learning landscape.

Closely linked with these recommendations is the approach for mitigating stormwater and conserving potable water supplies on campus.

1. Consider reduced parking (in tandem with other transportation demand management strategies) and underground parking within new buildings to limit surface area parking.
2. Develop habitat restoration plans for the escarpment slope, eastern meadow slope and pine woodland.
3. Plant trees in areas such as the escarpment slope which do not increase fire risk near buildings and infrastructure.
4. Review and identify opportunities to grow plant material on-site for use in landscaping and restoration activities.
5. Monitor storm water quality within the campus drainage system.

Potential Synergies or Points of Integration

- All of the measures proposed in this section support integration and mutual benefits between biodiversity, water and stormwater measures. Selective green roof installation also adds the potential of energy performance to the mix.
- Integration of recommended measures, policies and practices into upcoming capital and planning projects

Biodiversity Measure 2 Create a Campus Core that Integrates Buildings and Landscapes that Capitalize on Natural Systems	BIODIVERSITY	WATER	STORMWATER	ENERGY	WASTE

It should be noted that synergies exist beyond the individual examples provided through the graphic.

PLAN IMPLEMENTATION

Governance

Implementation of the *Whole Systems Infrastructure Plan* will require a collaborative and coordinated effort of many UBC constituents. The Emergent Governance Model described in the *Plan* assigns responsibility for developing and implementing the *Plan* as a companion to the *Campus Master Plan*.

Phase I represents the development of the technical and supporting analysis for the *Plan*. Within this phase, governance oversight has been provided by a Steering Committee comprised of representatives from UBC leadership, staff and academics. A Project Management Team has directed the project's overall technical and project management and the engagement of a Technical Working Group responsible for informing the *Plan*'s development. The planning process has been led by an interdisciplinary consultant team, responsible for development of the Roadmap, Targets and 5-Year Implementation Plan, supported by expert peer review. Stakeholders involved in Phase I include representatives from UBC Campus and Community Planning (C+CP), Campus Planning and Development (CP+D), Sustainability Office, Energy and Water Services, Campus Operations and Risk Management (CORM), Student Housing and Hospitality Services, IT Services, Infrastructure Development, UBC Properties Trust, Finance and Operations, Treasury, UBCO School of Engineering, UBC Centre for Interactive Research on Sustainability (CIRS), and UBC School

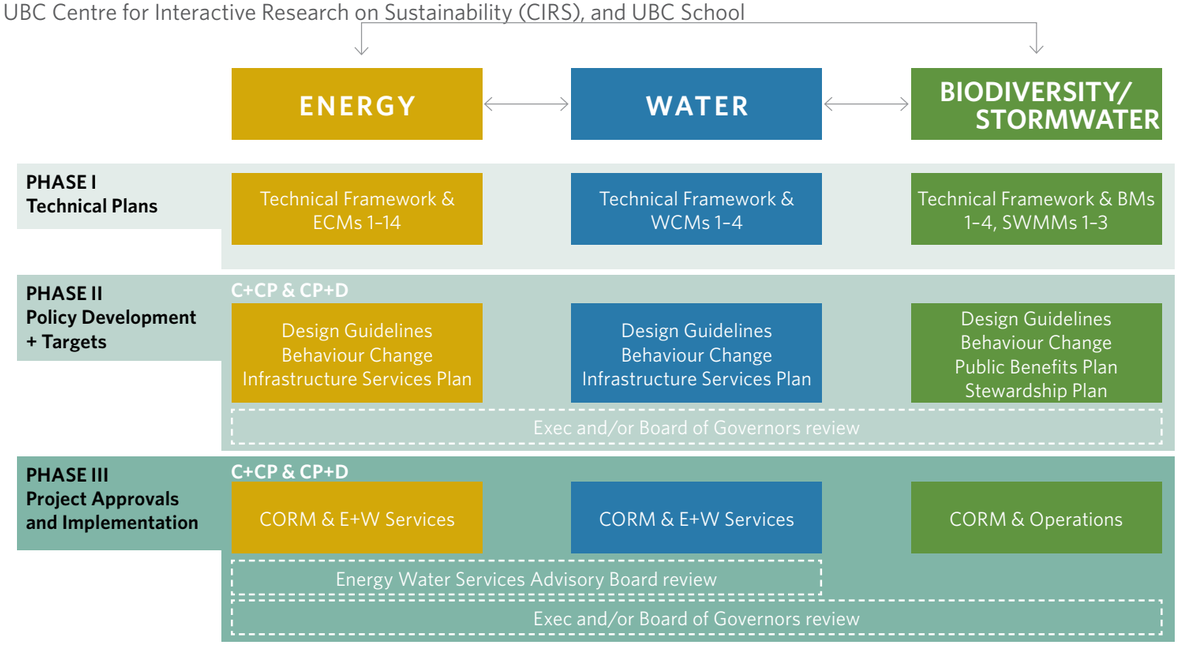


FIGURE 3: EMERGENT GOVERNANCE STRUCTURE

of Architecture & Landscape Architecture. FortisBC and GEID were consulted by the interdisciplinary consultant team as part of the planning process.

Phase II represents the policy and program development stage, which will be led jointly by C+CP—Campus Planning and Design and Sustainability and Engineering and UBC Okanagan CP+D – Campus Planning, Space Planning and Management and the Sustainability Office and advised by Campus CORM and UBC Vancouver Energy and Water Services. Informed by targets and recommendations in the *Plan*, these groups will be responsible for developing policy and programs to guide the implementation of the *Plan*. Future work will be informed by, but not be limited to developing:

- Detailed technical and financial feasibility studies for the DES and CHP infrastructure expansion;
- Detailed technical and financial feasibility analysis for biomass conversion;
- Amendments to the Design Guidelines for campus buildings and landscape;
- A detailed Infrastructure Servicing Plan to implement systems expansions proposed in the *Plan*;
- An updated *Stormwater Management Plan*;
- Behavior Change and Demand-Side Management Programs to help meet resource conservation targets and waste reduction goals; and
- A Public Benefits Plan, in collaboration with UBC Development and Alumni Engagement, that establishes an overall funding and stewardship approach with particularity attention to the Public Realm and related Biodiversity and Stormwater measures. This will include a detailed funding strategy that identifies sources of funding and the pursuit of industry partnerships, research and donor contributions.

Review and/or approval by UBC Executive and/or Board of Governors will occur at this stage as necessary.

Phase III represents the project approval and implementation phase. CP+D and CORM will be responsible for project viability and implementation, with CP+D—Sustainability Office responsible for awareness and behaviour change. CP+D and C+CP will be responsible for project approvals in accordance with the *Whole Systems Infrastructure Plan* and established processes. CORM will be responsible for implementing future infrastructure projects on campus, in accordance with the *Whole Systems Infrastructure Plan*. A proposed UBC Energy and Water Services Advisory Board will provide critical peer review for technical and financial feasibility of large-scale infrastructure projects such as the biomass energy and wastewater treatment systems, prior to executive and/or Board of Governors approval, as applicable.

Monitoring, Reporting Progress and Updating the Plan

The *Plan* is a living document that is intended to improve campus sustainability stewardship and performance and provide resiliency to future changes in climate, growth, utilities, and other unanticipated changes. The success of the *Plan*'s implementation is contingent on the collective and ongoing effort of UBC's planning and operational units, leaders, and key stakeholders.

The process of monitoring and reporting the *Plan*'s progress is an important diagnostic tool to understand progress toward the *Plan* and targets. Reporting provides disclosure and transparency to internal and external stakeholders on sustainability performance; allows for progress assessment against goals; and highlights the need for *Plan* updates that respond to changing needs, conditions or opportunities.

Campus Planning and Development, Sustainability Office will provide for the *Plan*'s monitoring and annual sustainability reporting against best practice standards and guidelines for data collection, analysis of performance and resource/cost savings impacts. This process will require the involvement and participation of key UBC staff across both campuses. Conceptual monitoring of measures and Key Performance Indicators for future implementation will occur by relevant units concurrently. Review for potential updates to the *Plan* will be undertaken as part of the *UBC Okanagan Campus Plan (2015)* review process, or prior where changing conditions require.

CREDITS

The University of British Columbia would like to acknowledge the work carried out by the UBC/UBCO Core Project Management Team, Steering Committee, Technical Team and Perkins+Will's consultant team which included AME Consulting Group, BTY Group, Smith + Anderson, PFS Studio, Raincoast Applied Ecology, 2020 Engineering and CTQ Consultants.

The University would also like to recognize the important contributions of the Rocky Mountain Institute as special advisors to the Project, as well as FortisBC for their sponsorship contribution to this planning exercise.

The UBC Okanagan Campus *Whole Systems Infrastructure Plan* was developed between January and September 2015 by Perkins+Will's interdisciplinary consultant team in collaboration with UBC Point Grey and UBC Okanagan, and with contribution from the Rocky Mountain Institute. The Whole Systems Infrastructure planning process occurred in parallel with and supports the *UBC Okanagan Campus Plan (2015)*. It responds to Campus Planning Principle #4, "Campus growth should be managed through a whole systems lens that incorporates environmental, economic and social sustainability outcomes, to achieve a net-positive impact on the well-being of the campus community and ecology," by establishing a future roadmap, targets and a 5-year implementation plan for improving the overall campus performance and ensuring that it is resilient to future changes in growth, utility rates, climate change and other unanticipated changes. This *Plan* will also position UBC as a leader in undertaking a whole systems approach to planning future infrastructure.

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