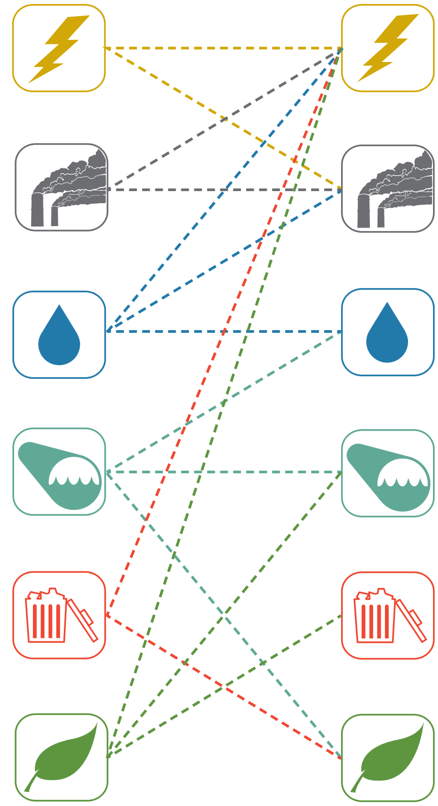
4 WHOLE SYSTEMS ROADMAP

The UBCO *Whole Systems Infrastructure Plan* establishes a roadmap for improving the overall performance of the campus between now and 2050, and is based on a set of working assumptions related to student growth and development. While balancing the sustainability goals of the University, the Roadmap identifies near and long-term measures, and prioritizes actions for the first 5 years. Near term measures are identified as those having a positive net present cost (NPC), an acceptable payback period, an acceptable payback period associated with leveraging cyclical maintenance, and/or changing business practices without operational costs.

The *Whole Systems Infrastructure Plan* establishes a roadmap for improving the overall performance of the campus between now and 2030, and outlines a vision for how it will:

- Achieve a 64% potable water use reduction over baseline;
- 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 46% carbon reduction for campus operations compared to the 2007 baseline (79% compared to BAU), and within range of attaining carbon neutrality through off-site partnerships.



Potential synergies between performance areas.

Achievement of this vision requires action and engagement at three important levels:

1. **Technological:** understanding the technical performance changes required to improve the performance of existing buildings, new construction, and landscaping projects as outlined in this infrastructure plan.
2. **Organizational:** identifying the institutional changes and/ or opportunities (i.e., policy, departmental, governance, and academic research) and funding needed to support a whole systems infrastructure approach.
3. **Behavioural:** establishing engagement and awareness programs necessary to facilitate conservation-based behaviour on campus by all (faculty, staff, and students).

The *Whole Systems Infrastructure Plan* recommends a framework and series of measures for each of the following performance areas, and calls out those measures most important to implement within the first 5 years for:

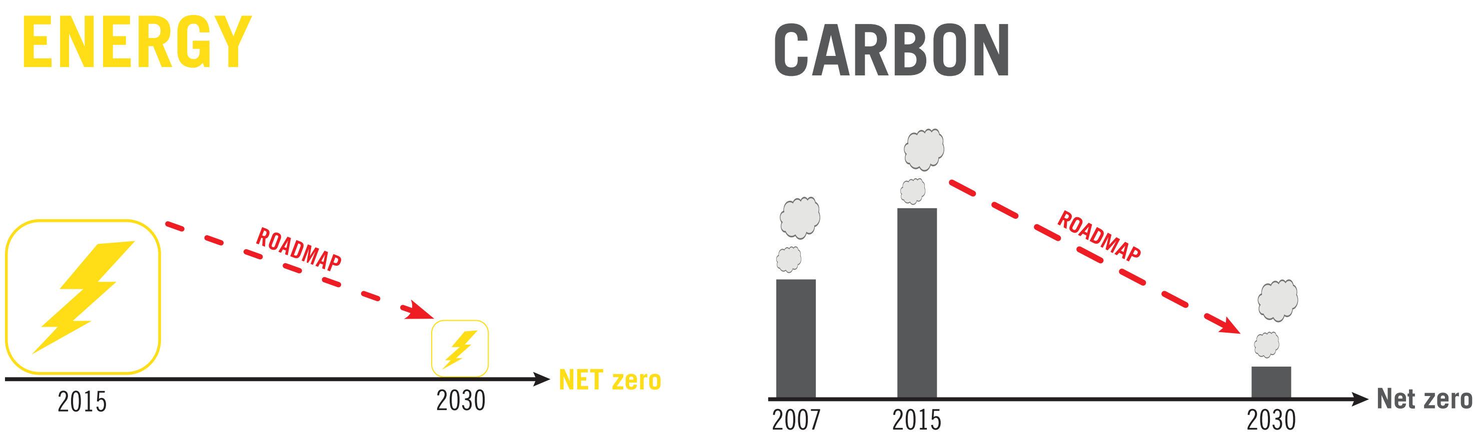
1. Energy and Carbon
2. Stormwater
3. Water
4. Ecological Landscape and Biodiversity
5. Governance and Implementation
6. Monitoring, Reporting and Updating the Plan

A detailed summary of the measures are presented in Part 2 of this *Infrastructure Plan*. These recommendations are based on principles of 1) reducing demand, 2) using resources (energy, water) more efficiently, 3) seeking alternative renewable resource supplies (water and energy), and 4) protecting and enhancing the natural landscape to increase biodiversity functions while also mitigating stormwater runoff.

The cost of inaction in each of these areas could be significant in a number of different ways:

- **Cost of Operations:** Inefficient performance of energy and water systems on UBCO Campus will lead to rising operational costs. This is of particular concern if utility rates and carbon tax costs increase in the future.
- **Cost of Carbon Offsets:** UBCO is responsible for off-setting carbon emissions based on provincial requirements. Based on UBCO's prioritization of energy conservation measures and preferred infrastructure approach, UBCO could realize up to $3 million in carbon offsets and carbon taxes savings by 2030.
- **Future Resiliency:** Changes in Federal and Provincial climate change policy, utility rates, carbon taxes, and the regional climate are imminent. Therefore, for example, investing in a water reuse treatment system will prepare the campus for anticipated water shortages for the region. More so, by expanding the CHP system, it will open the door for a wider range of renewable fuel sources and provide greater flexibility as compared to designing each new buildings with individual boiler systems. Switching to a biomass fuel source as part of the CHP expansion, UBCO could anticipate electricity, natural gas, carbon tax and carbon offset savings (escalated) of up to $31 million by 2030.
- **Loss of Biodiversity and Ecological Integrity:** Several species at risk have been identified on campus. Efforts should be made as the campus grows to protect, restore and manage the natural landscape in order to avoid loss of biodiversity and ecological functions while maintaining additional social sustainability values.
- **Institutional Leadership:** Universities compete annually for leadership status. Through the development and more importantly the implementation of this infrastructure plan, it will bolster UBC's leadership status regionally, nationally, and globally.
- **Institutional Reputation:** Universities market actively the merits of their campus and programs to attract, retain, and recruit new faculty, staff and students. Inaction in the sustainability arena could impact the University's reputation.

The opportunity for realizing this vision is presented below.



4.1 ENERGY AND CARBON

In 2010, UBC established a long-term vision and framework for attaining carbon neutral operations by 2050, with interim targets for its Point Grey Campus of 33% (by 2015), 67% (by 2020) and 100% (by 2050) below 2007 emissions as per the UBC *Climate Action Plan*. UBCO faces a challenge in reconciling energy costs and its long-term GHG emissions, and this *Infrastructure Plan* provides a roadmap and milestone metrics for GHG emissions reductions related to building operations. Campus electricity accounts for 65% of the overall campus energy consumption and 80% of overall energy cost per year; while natural gas accounts for as much as 96% of the campus carbon emissions.

GOAL #1:
Achieve a net positive performance in operational energy and carbon.

GOAL #2:
Implementation of a framework that supports low embodied carbon in future development.

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

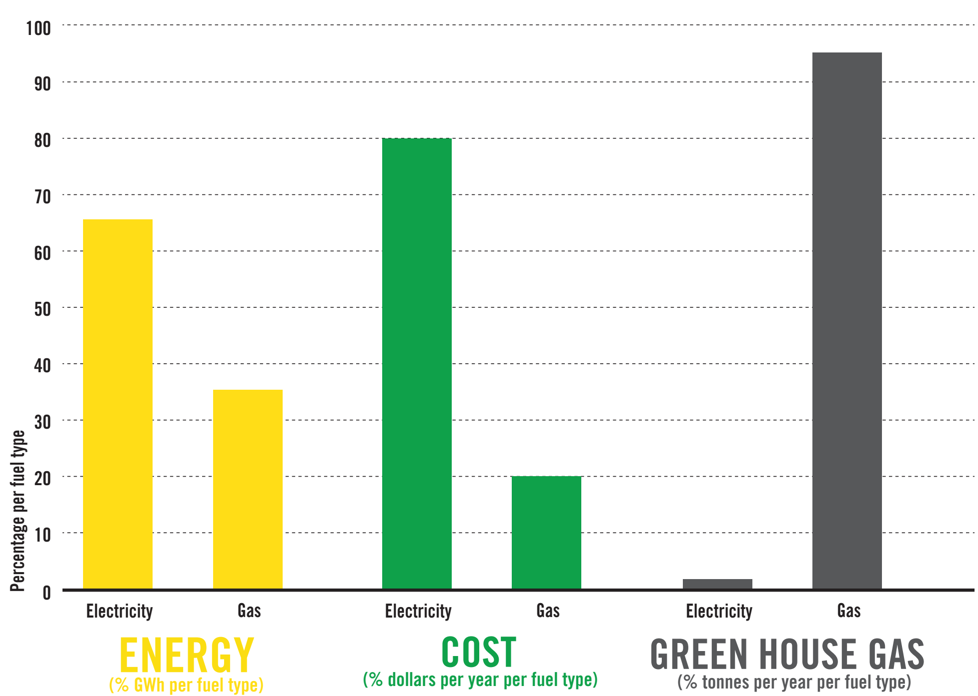


FIGURE 2: UBCO 2013 ENERGY—COST—GREENHOUSE GAS PROFILE

The *Whole Systems Infrastructure Plan* outlines an approach for reconciling this challenge and for achieving significant carbon reductions for UBC Okanagan Campus despite the potential doubling of campus building area and population by 2030.

Immediate implementation of energy and demand-side energy conservation measures will result in near-term electrical cost savings which can be used to finance measures that support large carbon reductions. Through implementation of a multi-pronged approach, UBCO could realize the following milestone targets:

- by 2020 achieve 33% carbon reduction as compared to BAU;
- by 2025 achieve 73% carbon reduction as compared to BAU; and
- by 2030 achieve 79% carbon reduction as compared to BAU.

The *Whole Systems Infrastructure Plan* outlines the following framework for achieving an optimized campus system and the long-term campus energy and carbon goals:

1. Form a campus energy management team to implement the *Infrastructure Plan* recommendations;
2. Create a revolving fund to finance ongoing energy improvements. This fund could be established from savings gained from the implementation of electrical and demand-side savings measures;
3. Establish baseline utility model in order to track savings;
4. Develop a campus-wide Behaviour Change and Engagement Strategy to promote and support campus awareness for resource conservation and DSM strategies required for whole systems plan implementation;
5. Develop and implement existing buildings energy conservation measures to achieve 5 year plan targets, reduce energy consumption of district energy systems, and make capacity available for future growth;
6. Update campus *Design Guidelines*, *Technical Guidelines*, and *LEED v4 Implementation Guide* with guidance for energy performance of new construction and energy efficient systems;
7. Optimize and verify the performance of the DES and continue to connect to academic buildings for heat sharing and cooling.
8. Expand CHP and DES piping systems as the campus constructs new academic and residential buildings;
9. Phase in fuel switch to carbon neutral sources to serve academic and residential buildings;
10. Plan for and pilot the integration of renewable energy technologies (i.e. solar PV) as the business case becomes more viable; and
11. Consider off-site partnerships to reach carbon neutrality by 2050.

Greater detail regarding this framework is presented in Part 2. An overall recommendation that includes the bundling of certain energy and carbon performance measures is presented in this *Infrastructure Plan*, and is summarized as follows:

- Implementation of academic building energy conservation measures coupled with phasing in a biomass central heating plant that connects both new academic and residences could result in 46% reduction in GHG emissions over 2007 baseline;
- Further reductions of 1-2% could be realized by installing solar photovoltaic systems on new academics buildings as the cost of solar technologies become a financially viable renewable energy source in British Columbia; and

System interactions occur between many of the recommended energy and carbon reduction measures as shown in Figure 3.

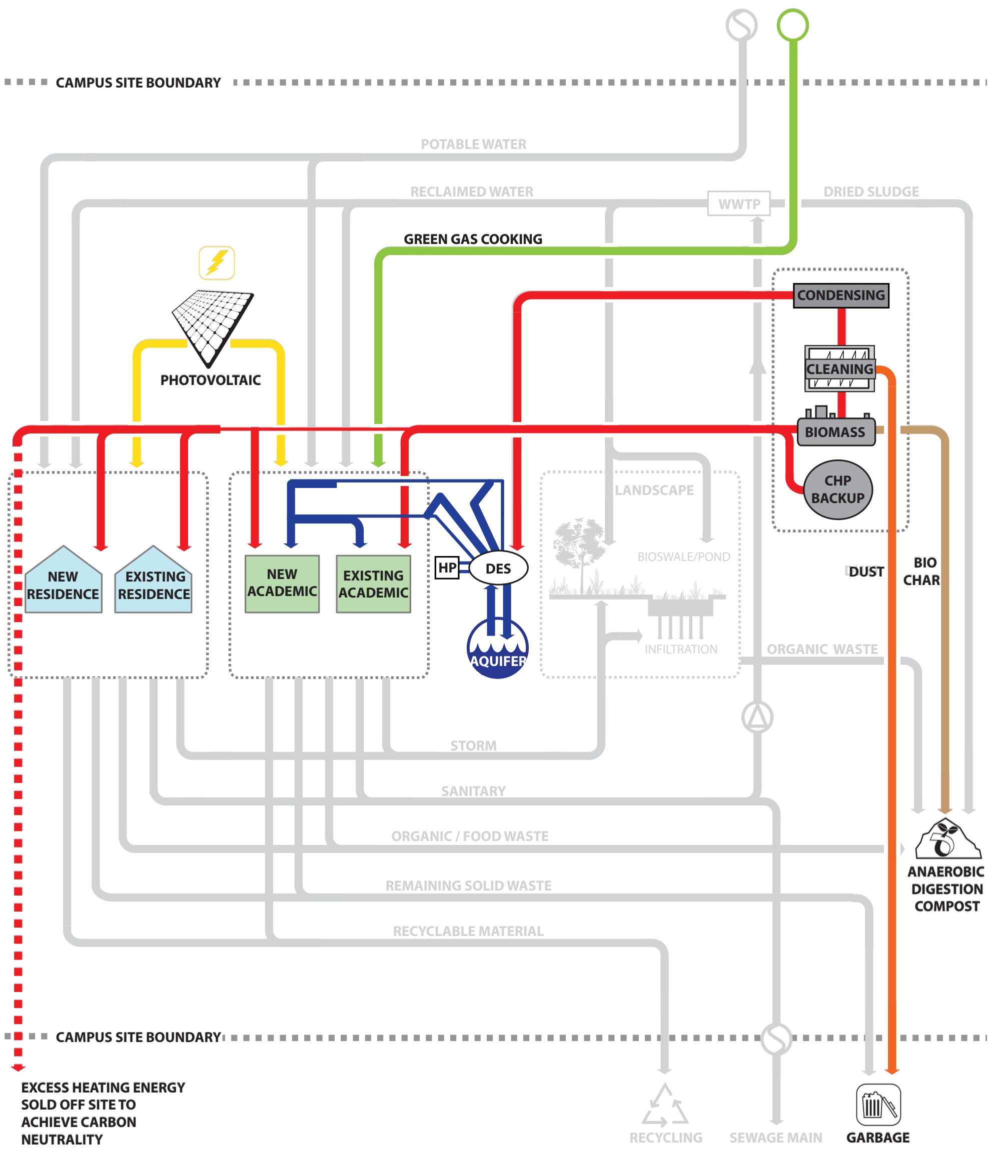


FIGURE 3: ENERGY SYSTEMS MAP

- Attainment of carbon neutrality by 2050 could be realized through off-site partnerships with local industry.

Figure 3 is an energy systems map that shows conceptually how the campus energy infrastructure could evolve to integrate renewable fuel sources including biomass and photovoltaics systems, along with exploring off-site partnerships to reach the long-term goal of achieving carbon neutrality.

Figure 4 summarizes the energy and carbon plan as it relates to achieving UBCO's overall goal of achieving a net positive performance in operational energy and carbon. It also shows the preferred sequencing of energy conservation measures.

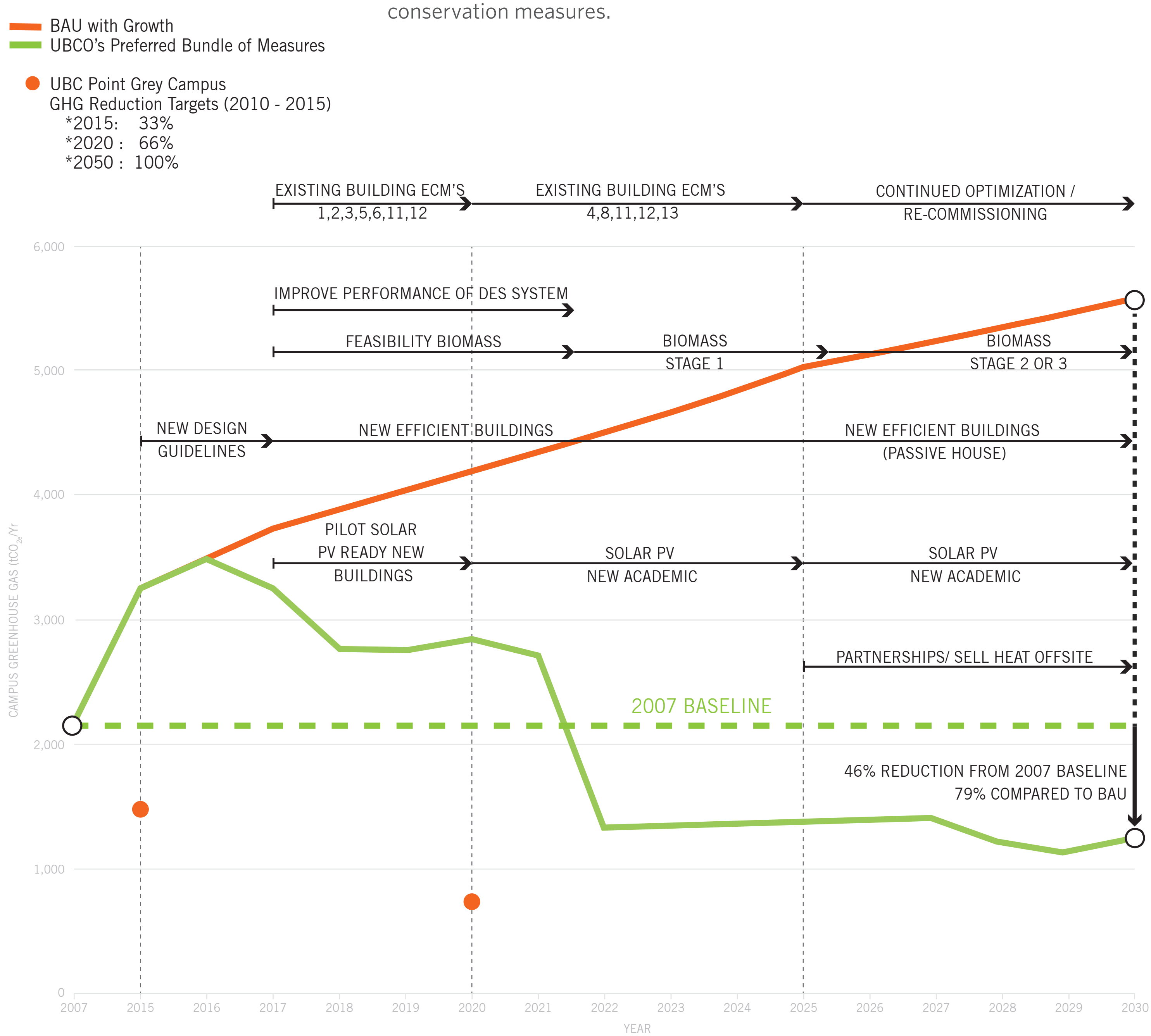
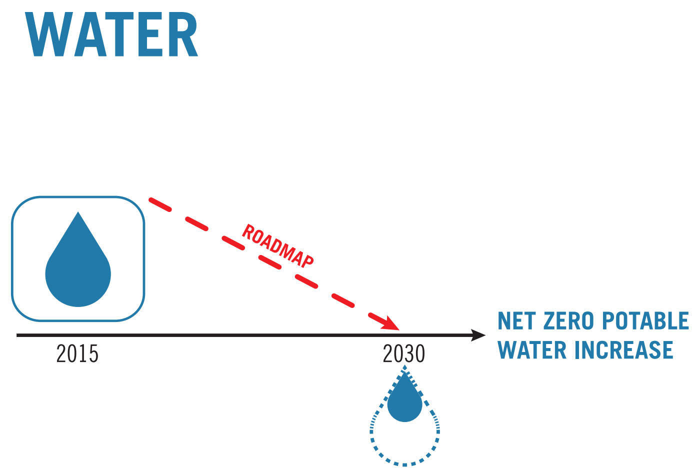


FIGURE 4: CAMPUS GREENHOUSE GAS EMISSIONS REDUCTION APPROACH

4.2 WATER



Water scarcity is a global priority, and is largely driven by climate change and lack of water demand-side management programs. A bold shift and commitment by UBCO is required to take a regional leadership position in implementing water conservation, on-site treatment and reuse best practices that are necessary for preparing the campus for anticipated long-term water shortages in the Okanagan region. The University is well-positioned to serve as a regional catalyst in demonstrating water conservation best practices. This leadership position will require taking a long-term vision to overcome near-term financial obstacles for the proposed water conservation and reuse plan. Despite the assumed doubling of campus building area and population by 2030 as compared to today, the *Whole Systems Infrastructure Plan* proposes a strategy that will enable the Campus to use less potable water and realize a net positive impact.

GOAL #3:
Optimize water quality, supply and security.

The *Whole Systems Infrastructure Plan* recommends the following framework for realizing a net positive outcome in terms of water performance:

1. Establish a water monitoring strategy to develop an accurate water use baseline for campus operations 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 a 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 a drip irrigation system;
4. Update UBCO's *Design Guidelines, Technical Guidelines, and UBC LEED v4 Implementation Guide* for expected water performance of new construction and existing building upgrades;
5. Develop campus wide Behaviour Change and Engagement Strategy to promote and support campus resource conservation and DSM strategies required for whole systems plan implementation;
6. Pilot purple pipe installation in a new construction and a retrofit project on campus to determine the incremental cost and viability of preparing the campus for an on-site water treatment facility;

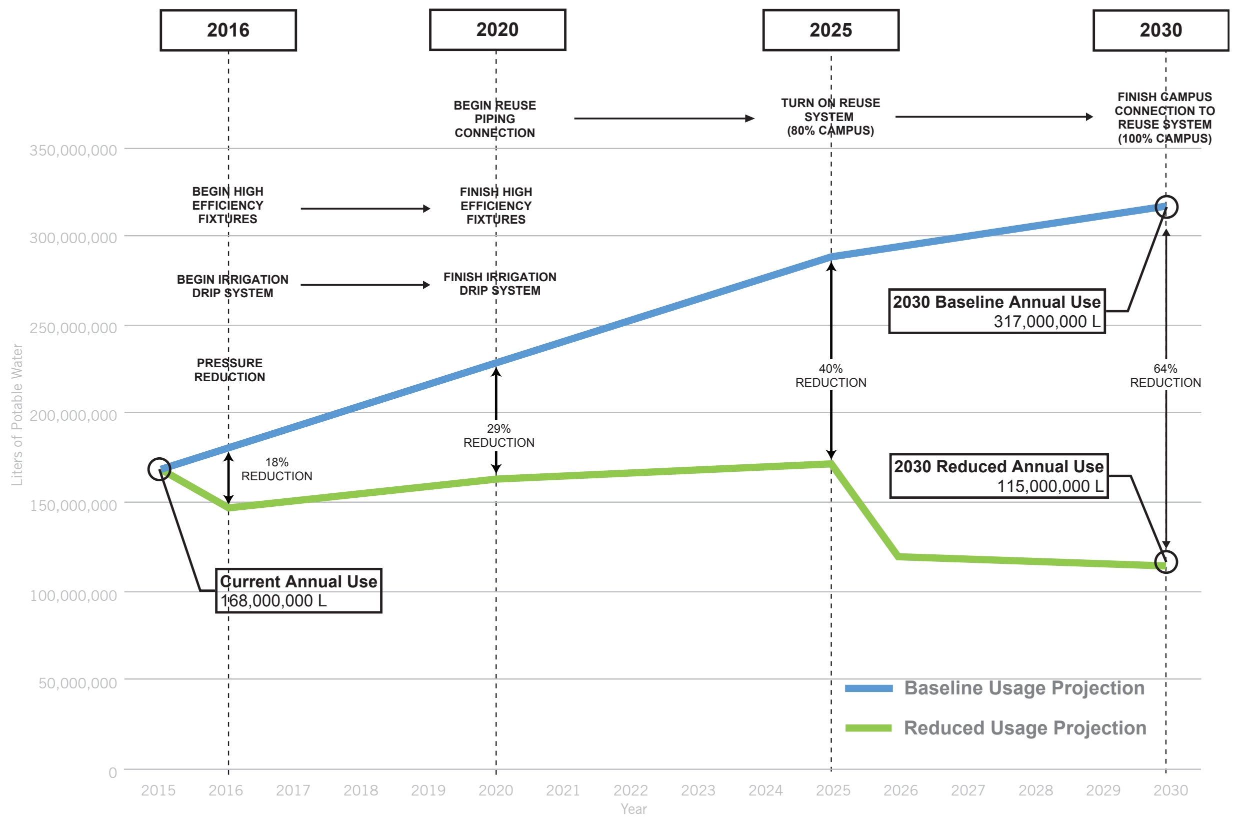


FIGURE 5: PROJECTED POTABLE WATER CONSERVATION SAVINGS

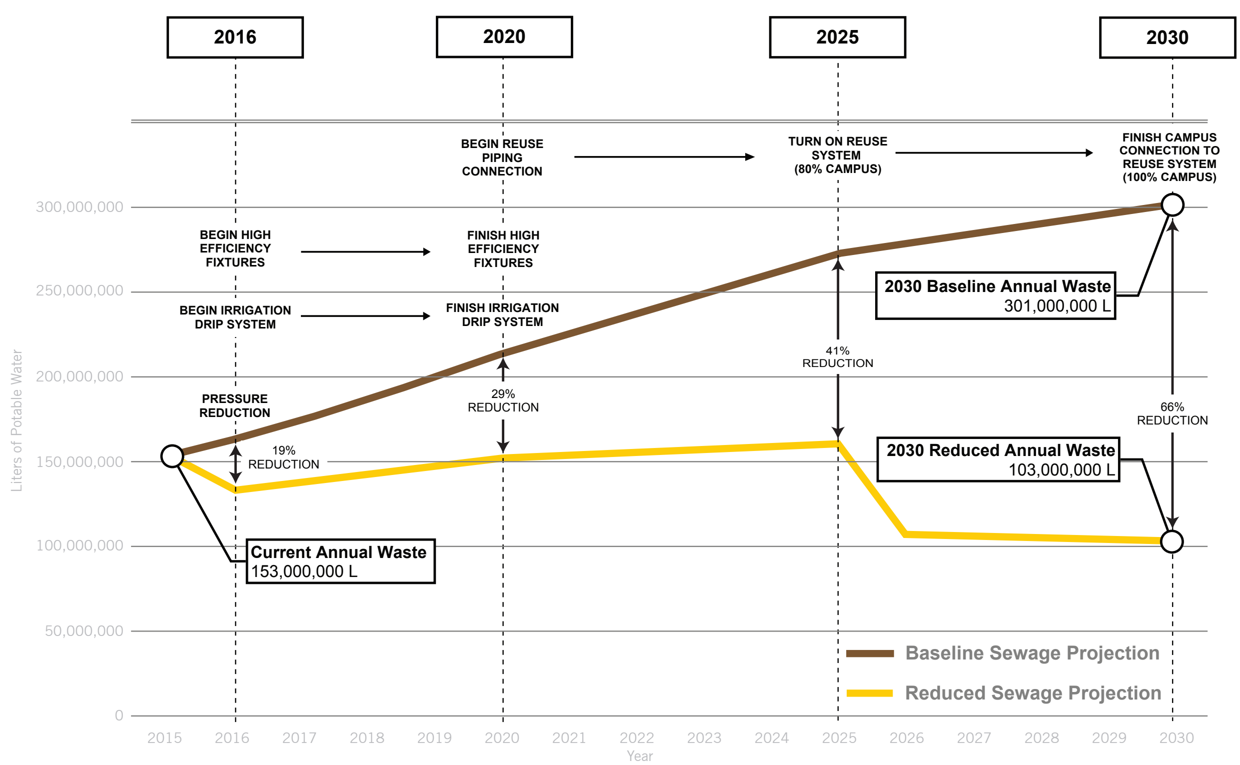


FIGURE 6: PROJECTED SEWAGE REDUCTION

System interactions occur between many of the recommended water measures as shown in Figure 7.

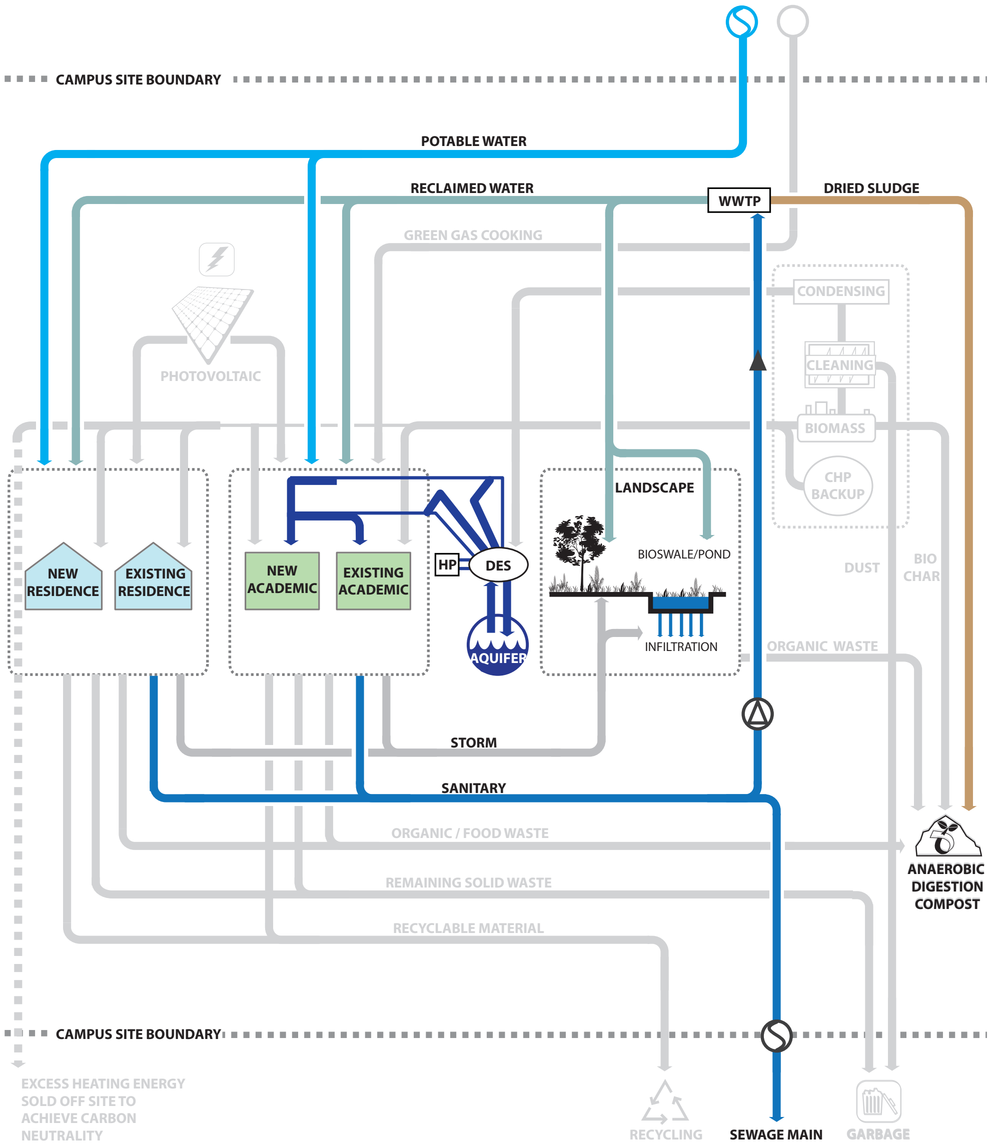


FIGURE 7: WATER SYSTEM MAP

7. Phase in purple pipe distribution for reclaimed water as DES and CHP expansion 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;
8. Monitor the key performance indicators for broader adoption of purple pipe ready buildings and campus wide infrastructure; and
9. 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 potential escalation in water rates.

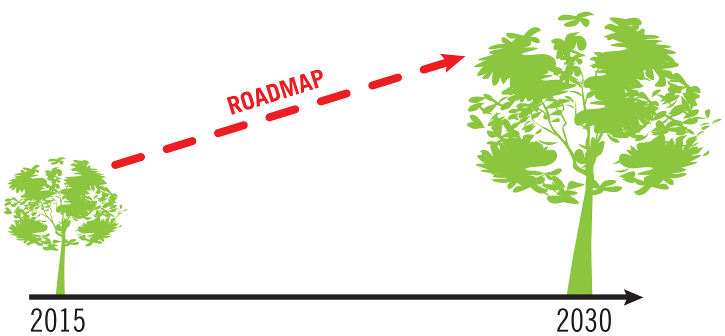
Figure 5 and 6 show the recommended phasing of water conservation measures, milestone savings and sewage reduction between now and 2030, while accounting for projected growth. Through implementation of multi-pronged approach, UBCO could realize the following milestone targets:

- by 2020 achieve 29% water use reduction as compared to BAU;
- by 2025 achieve 40% water use reduction as compared to BAU; and
- by 2030 achieve 64% water use reduction as compared to BAU.

Figure 7 illustrates the potable and sanitary systems on campus, and the possibility of introducing a wastewater treatment plant (WWTP) to provide reclaimed water to service academic and residential buildings, and landscape irrigation. The systems map shows the interactions between water, waste, stormwater and landscape systems, and the future potential of managing these resource flows on campus (i.e., diverting sewage sludge to anaerobic digestion compost system).

4.3 ECOLOGICAL LANDSCAPE AND BIODIVERSITY

BIODIVERSITY



GOAL #4:
Enhance and/or restore the ecology.

Ecosystems play a vital role in providing a range of services in terms of supporting soil formation, providing fresh water and habitat, regulating climate, 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.

Successful implementation of this vision can be measured against an overarching metric of amount of natural area (ha) that will increase on campus over time. Part 2 outlines additional metrics that could be developed to track, for example, increase in native habitats, biodiversity, and social engagement.

The following framework is recommended for restoring and enhancing the ecological landscape at UBCO and is consistent with the 2015 Campus Plan:

1. Protect 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 plant communities 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. Synergies between systems are discussed in greater detail in Part 2, and are illustrated, for example, in Biodiversity Measure 2 listed below.

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

4.4 STORMWATER

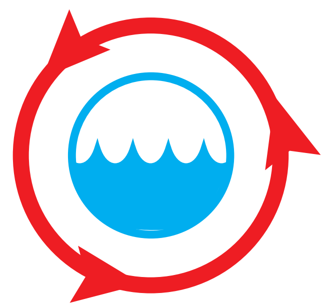
100% of stormwater is currently managed on-site at UBCO through an existing network of storm pipes, overland flow routes, ditches, swales and ponds. The *Whole Systems Infrastructure Plan* builds upon existing stormwater planning efforts to provide a framework that integrates low impact development (LID) strategies that will enable the campus continue to divert 100% of stormwater from municipal systems between now and 2030:

1. Collect and filter stormwater to an enhanced and expanded wetland network;
2. Where conditions permit on campus, infiltrate runoff from buildings and impervious surfaces in the campus core;
3. Implement specific stormwater improvements relative to the 2011 *Stormwater Management Plan* 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.

Closely linked with these recommendations is the approach for enhancing and restoring biodiversity functions on campus, as illustrated below:

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

STORMWATER



2030

**GOAL #5:
100% diversion of storm-water from municipal systems**

4.5 OPTIMIZING PERFORMANCE AND SYNERGIES

Through the implementation of the *Whole Systems Infrastructure Plan*, significant savings will be realized across all performance streams and the following metrics and targets are recommended for future tracking and monitoring of UBCO's success.

TABLE 3: 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%

Across each of the performance areas (energy and carbon, ecological landscape and biodiversity, and stormwater), synergies are realized in multiple ways and these are discussed in greater detailed in Part 2 of the *Infrastructure Plan*:

- **Strategic phasing:** Strategic phasing of key infrastructure measures will allow for simultaneous scheduling and installation cost savings. For example, it is recommended to phase in purple piping with the expansion of the DES and CHP infrastructure system to realize efficiency with infrastructure construction costs. Phasing of key infrastructure systems are detailed in series of infrastructure phasing maps presented in Figures 8 and 9, as well are presented in Part 2.
- **Multiple technical benefits derived from single measures:** One of the key benefits of undertaking a whole systems approach is the opportunity to capitalize on multiple benefits and synergies resulting from the interconnection points of performance measures. Measures related to the ecological landscape and biodiversity functions have synergistic benefits with water, stormwater, and energy performance areas. For example, expanding a network of wetlands on campus not only increases the biodiversity potential on campus, but assists with mitigating stormwater on-site and contributes to the overall learning landscape.

- **Multiple qualitative benefits derived from the *Plan*:** Many qualitative benefits may be attributed to undertaking this planning effort and implementing the recommendations. Increasing UBCO's sustainability leadership position, opportunity to secure new donor funding, and ability to attract, recruit, and retain new faculty, staff and students are all potential benefits resulting from this effort.
- **Multiple quantitative benefits derived from the *Plan*:** Through implementation of the Plan, the University could realize significant savings in greenhouse gas emissions, potable water and energy use reduction, and in turn economic savings. It is estimated that the University could anticipate electricity, natural gas, carbon text, and carbon offset savings (escalated) of up to $31 million by 2030.

Figure 8 and 9 illustrates at a conceptual level the flow and distribution of resources on campus, and how resources can be managed on campus (i.e., stormwater) and the potential for long-term off-site partnerships (i.e., selling heat off-site, green gas) may assist UBCO in reaching its carbon neutrality target. It also depicts how the measures proposed in this *Whole Systems Infrastructure Plan* come together to optimize the performance of buildings (i.e., energy and water meters, purple piping, LID strategies, building scale renewables) and the overall campus with the ultimate vision of realizing net positive outcomes in terms of performance. Appendix A summarizes all of the recommended measures and the potential synergies that exist between them. Appendix B includes conceptual service plans for the proposed Infrastructure Plan systems.

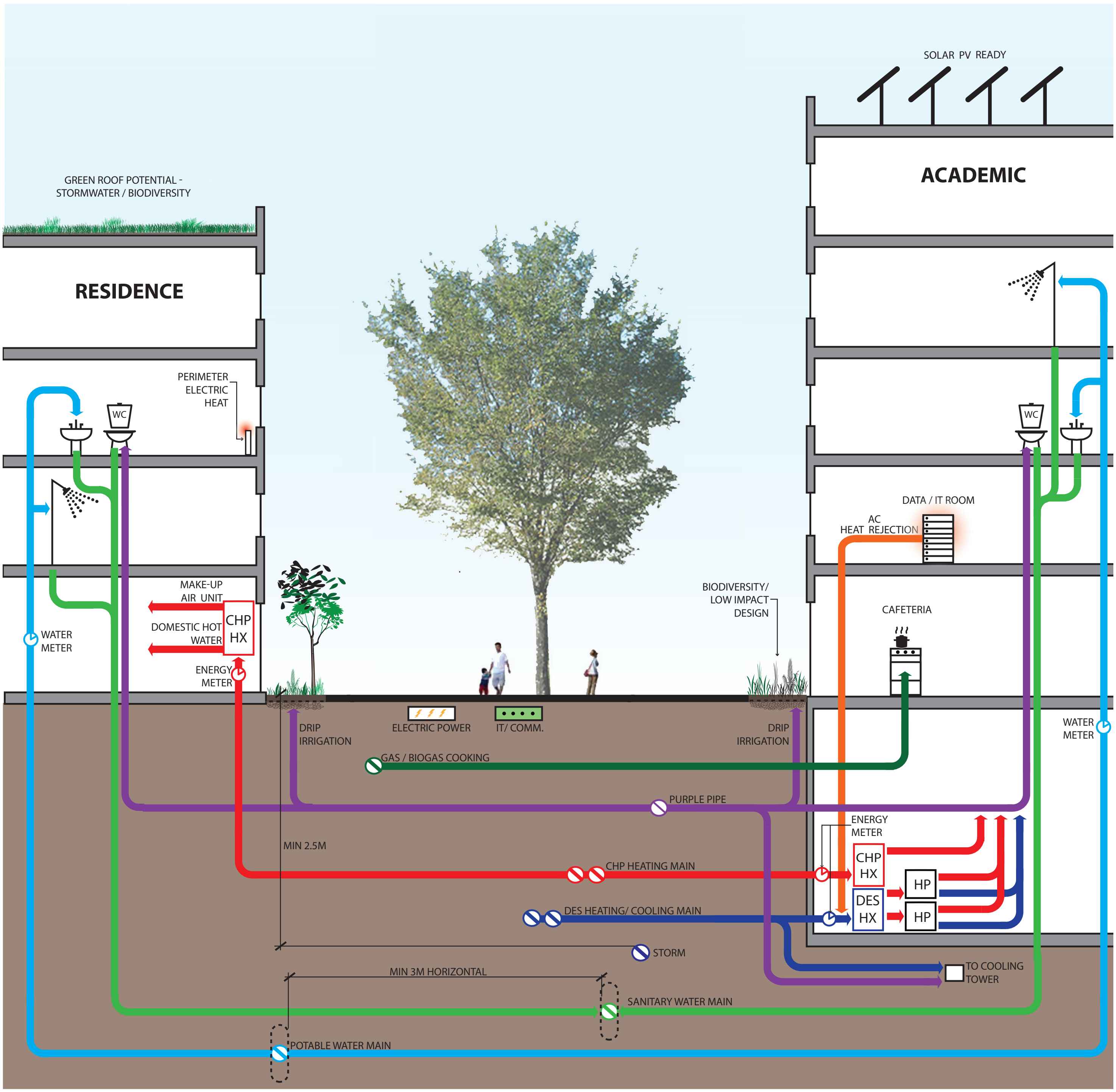


FIGURE 8: UBCO STREET SECTION

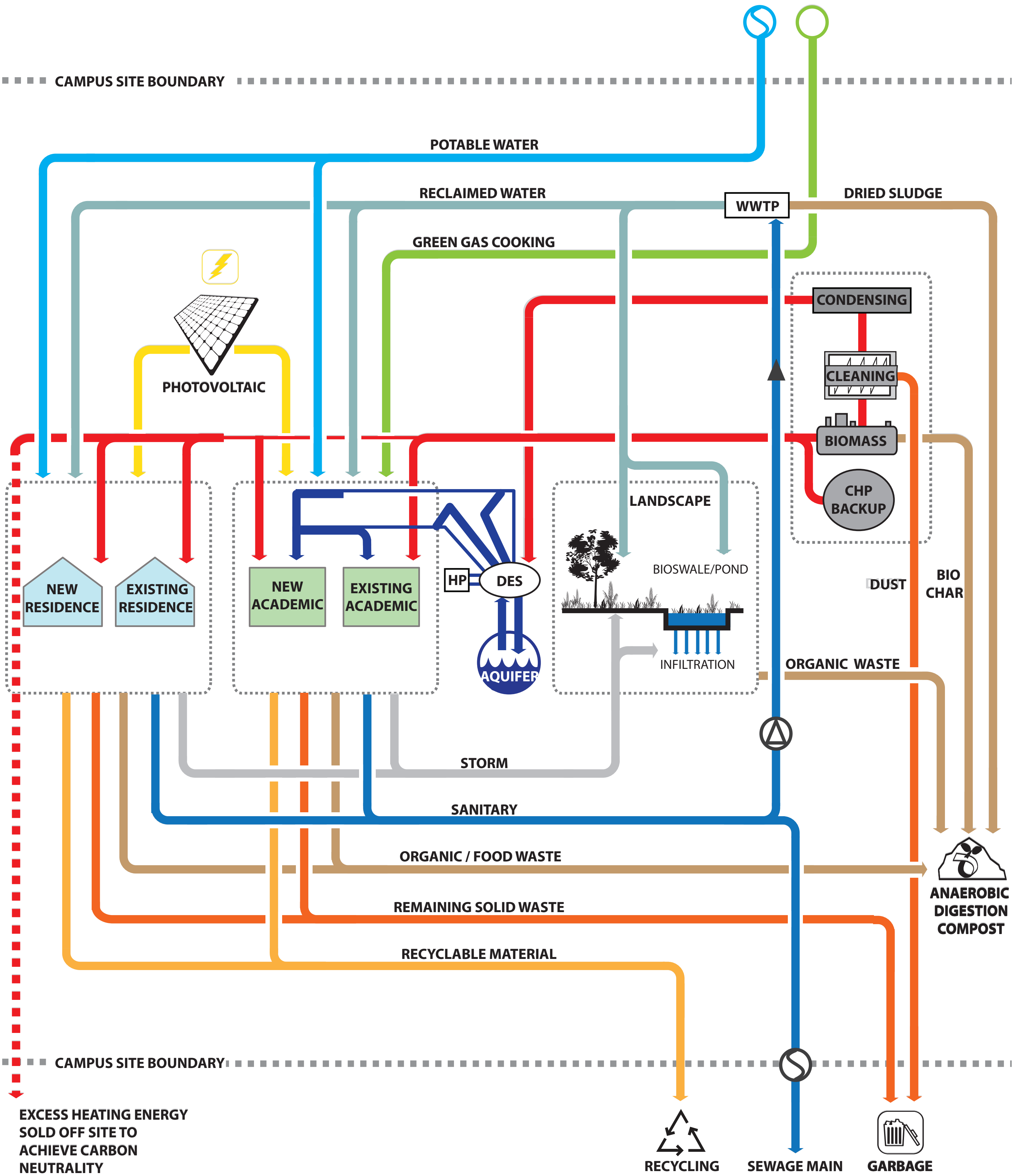


FIGURE 9: UBCO WHOLE SYSTEM INFRASTRUCTURE MAP