BIOENERGY RESEARCH & DEMONSTRATION FACILITY

Expansion Project

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THE UNIVERSITY OF BRITISH COLUMBIA

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Civil Engineering
UBC Facilities

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AUTHORSHIP & ACKNOWLEDGMENTS

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Information in this case study draws from a range of sources, including:

- *Exploring digital project delivery in renovation projects: a case study of UBC's Bioenergy Research Demonstration facility expansion projects* by Seungho Han, Master of Applied Science thesis, UBC Civil Engineering, 2021
- *Bioenergy Research and Demonstration Facility - Review and Analysis of Research Program* by Amanda Johnson, UBC Sustainability Scholar Report, 2019
- Interviews with UBC project managers, operational staff, and engineers involved in both the design/construction and commissioning/optimization phases of the expansion.
- Site tours, operational data, and internal project documentation provided by Energy & Water Services, Project Services, and the BRDF operations team.

PROJECT CONTEXT

Martin Dee

PROJECT FACTS

- Original capacity: 7 MW thermal energy + 2 MW electrical energy
- Added capacity during expansion: 12 MW thermal energy
- Total new capacity: 19 MW thermal energy + 2 MW electrical energy
- Total new GHG emissions reduction: 23,000 tonnes of CO2 per year
- Expansion project budget: $20.4 million CAD (2017)

The University of British Columbia has made a commitment to tackle the climate emergency by setting an accelerated pathway for emission reductions. In its Climate Action Plan 2030 (CAP 2030), UBC established a 2030 greenhouse gas (GHG) reduction target for the Vancouver campus of 85% below 2007 levels, building on earlier actions that had already achieved a ~30% reduction.

A key contributor to these reductions has been the Bioenergy Research and Demonstration Facility (BRDF), an on-campus energy generation plant that converts renewable biomass from wood waste into thermal energy for campus buildings. Since its commissioning in 2012, the BRDF has played a central role in advancing UBC's sustainability goals—reducing campus GHG emissions by approximately 14% compared to 2007 levels, diverting 10,000 tonnes of wood waste annually from landfill, and displacing 8,500 tonnes of fossil fuel-based CO_2 emissions per year.

To meet CAP 2030's ambitious targets and address increasing campus energy demand, UBC initiated the BRDF Expansion Project. The expansion's rationale was twofold: to significantly increase the facility's thermal energy generation capacity—moving from 7 MW to 19 MW—and to provide the majority of campus heating and hot water needs from renewable sources for 8–9 months of the year. This shift would further displace fossil fuel use, contribute an estimated 14,500 tonnes in additional annual GHG reductions, and strengthen campus energy resilience.

Given the complexity of expanding an operational energy facility within a confined footprint, the project relied heavily on Virtual Design and Construction (VDC) tools and processes, including an integrated Building Information Model (BIM) to plan installation sequencing, anticipate challenges, and coordinate multiple trades. In parallel, the project included the construction of the Biorefining Research and Innovation Centre (BRIC)—a $7 million research facility adjacent to the BRDF—led by faculty members from the Faculty of Applied Science and the Faculty of Forestry. BRIC expands UBC's capacity to develop, test, and scale new biomass conversion technologies at an industrially relevant scale.

The BRDF Biomass Expansion Project unfolded in two major phases:

- Phase 1 (2017–2023): Design, procurement, construction, installation, and initial testing of the new biomass combustion and thermal energy systems, fuel handling infrastructure, and the BRIC building. This phase also saw the integration of advanced project delivery technologies such as VDC and BIM to manage spatial constraints and optimize installation logistics.
- Phase 2 (2023–2025): Commissioning, post-installation optimization, and system integration—addressing equipment and design deficiencies, upgrading thermal and fuel handling systems, and implementing operational improvements to ensure the facility met its intended capacity and performance targets.

This case study documents both phases, highlighting the innovative approaches, technical challenges, key operational learnings, and the integration of applied research throughout the process. The report draws on a wide range of sources, including academic research, project documentation, operational data, and first-hand insights from UBC staff and subject-matter experts, complemented by interviews, operational records, and site tours conducted in 2025 to ensure the case study reflects the full lifecycle of the expansion.

ORIGINAL FACILITY

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SYSTEM OVERVIEW

The original BRDF featured two systems: a biomass heat generation system to produce thermal energy, and a biomass cogeneration demonstration system to produce thermal and electrical energy.

The first heat generation system used commercially proven gasification technology to convert biomass (in the form of wood chips), into a synthesis gas or syngas. The syngas was used as an alternative to natural gas to produce hot water for the Academic District Energy System.

The biomass cogeneration demonstration system consisted of a cogeneration engine which used conditioned syngas in place of natural gas to produce electricity for the campus grid. The cogeneration system was a pilot demonstration of novel technology and was in operation for 450 hours before an equipment failure. Unfortunately, it was not economically feasible to repair or replace the equipment at that time. In 2014, the cogeneration engine underwent a transformational dual-fuel upgrade and since then has been in operation using a combination of renewable natural gas and natural gas.

After the 2014 update, the BRDF biomass heat generation system produced 6 megawatts (MW) of thermal energy each year plus an additional 0.5-1 MW of thermal energy from heat recovery, meeting 25% of annual total campus thermal energy needs. The upgraded cogeneration systems produced 2MW of electrical energy every year, meeting 5% of total campus needs.

ORIGINAL ENERGY GENERATION SYSTEMS

1. The gasifier converts the wood waste biomass into a clean synthesis gas (syngas).

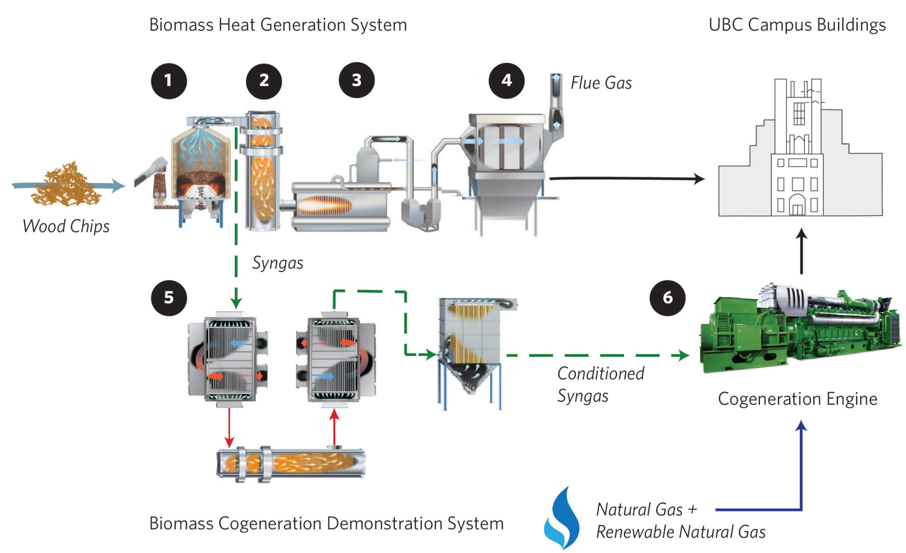
2. The syngas is combusted in the oxidizer and the resulting flue gas is directed through the boiler.

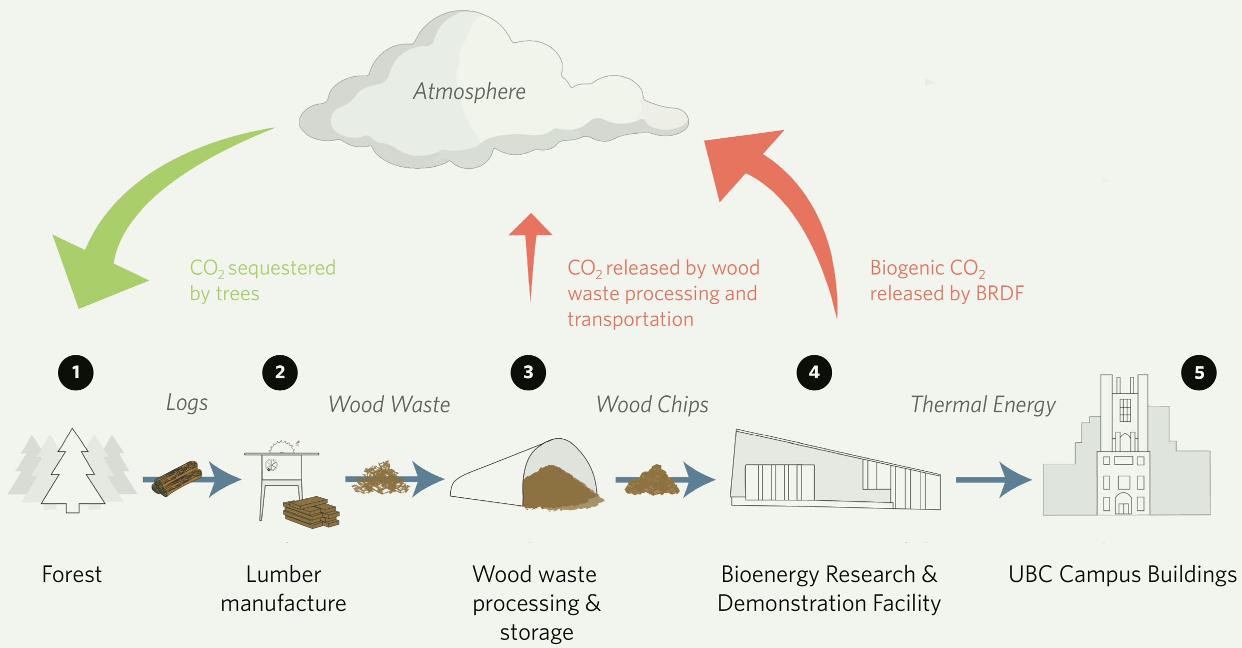
3. Hot flue gas enters the boiler to produce steam for campus heat distribution.

4. The electrostatic precipitator filters the particles in the flue gas, which is then released into the atmosphere.

5. In the demonstration system, syngas was conditioned and filtered from impurities to fuel the cogeneration engine.

6. The cogeneration engine used renewable natural gas and natural gas to generate electricity and heat.





WASTE TO ENERGY

An estimated 1 million tonnes of wood waste are produced annually within the lower mainland of BC, from sources such as sawmills, construction, land clearing and trimmings. However, only half of this wood waste is estimated to be currently used. This wood waste biomass is a readily available resource that is less expensive to buy per unit of energy than natural gas and diesel and often more stable in price.

BRDF CARBON CYCLE

1. Trees absorb on average 200 kg of CO2 from the atmosphere over an 80-year life span. Forest trees are harvested in the form of logs.

2. Harvested logs are processed for lumber to be used in construction and furniture manufacturing, which creates waste wood and sawdust by-products.

3. The clean wood waste from sawmills is collected and processed into wood chips to be used as biofuel, instead of being sent to a landfill.

4. The wood chips are transported to BRDF at the UBC campus to fuel the biomass heat generation system and produce thermal energy.

5. Thermal energy in the form of steam is converted into hot water, which is then distributed around the UBC campus to heat the buildings.

THE BRDF BUILDING

The LEED Gold building that houses the BRDF was one of the first industrial buildings in Canada to be constructed with cross-laminated timber (CLT) panel technology. The structure is composed of exposed CLT panels for the walls, floors and roof; glued-laminated timber (glulam) columns and beams attached through steel connectors; and a slab-on-grade concrete foundation. The CLT panels were fabricated locally, mostly from regionally-sourced 90% pine beetle-affected lumber.

The BRDF's central location on UBC's Vancouver campus near the Marine Towers student residence was strategically chosen to facilitate the logistics of biomass delivery within the campus and to demonstrate that biomass utilities can exist safely in urban environments. The architecturally striking building is situated within a small forested area in close proximity to student residences, research labs, offices and operations facilities.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CAMPUS AS A LIVING LAB PROJECT

UBC Campus as a Living Lab (CLL) is a collaborative framework that leverages the university academic and operational capabilities to respond to global sustainability challenges. CLL projects integrate research and teaching with the development and operation of campus infrastructure to explore, develop and test new ideas, and share the knowledge gained from these experiences.

The original BRDF project was a flagship CLL project and collaboration between UBC Facilities, Energy & Water Services, academic researchers and industry partners. It established a model of using a campus energy infrastructure project to pilot new technology, support research and teaching, and advance campus sustainability goals.

To support academic research, the original BRDF included an on-site laboratory that enabled researchers to access the syngas, as well as products and byproducts from the energy generation systems. Faculty and students from the Department of Chemical and Biological Engineering were the primary researchers, studying topics including fuel quality and waste logistics, tar cracking, emissions and air quality. Between 2012 and 2025, there have been 10 peer reviewed papers, 3 graduate theses, 8 undergraduate student projects and at least 15 professional reports concerning the BRDF.

As part of the BRDF Expansion Project, the research capabilities were expanded through the addition of a new dedicated lab, the Biorefining Research and Innovation Centre.

BIOMASS EXPANSION PROJECT

Henri Tsai

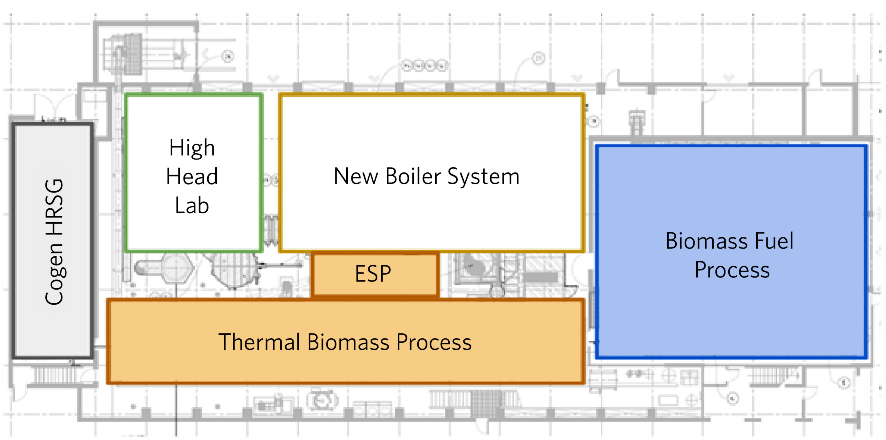
FACILITY EXPANSION

As part of the strategy to become a net-zero emission campus, in 2018 the UBC Board of Governors approved the BRDF Expansion Project to significantly increase thermal energy generation capacity on campus. The BRDF Expansion Project included:

- A new hot water generator boiler system
- A new and expanded fuel conveying system
- A larger fuel storage bunker for increased capacity (up to 4 deliveries)
- Modifications to existing facility to improve functionality and access
- A new on-site laboratory, the Biorefining Research and Innovation Centre (BRIC)

The original budget for the expansion project was $20.4 million CAD (2017) with $7.6 million support from the federal government's Low Carbon Economy Fund. The expansion project is predicted to provide a positive return on UBC's investment by 2028 through an additional $1 million in operational savings annually, which will be used to pay down the University's contribution to the expansion.

The expansion of BRDF was a key strategy to achieve UBC's Climate Action target of reducing the campus GHG emissions by 85% below 2007 levels by the year 2030. The expanded facility is predicted to eliminate an average of 23,000 tonnes of GHG emissions annually. It will generate the majority of UBC's thermal energy through biomass and fulfill 100% of the UBC campus's heating and hot water needs for 8-9 months of the year. The total thermal energy capacity of the expanded BRDF will be 19 MW.



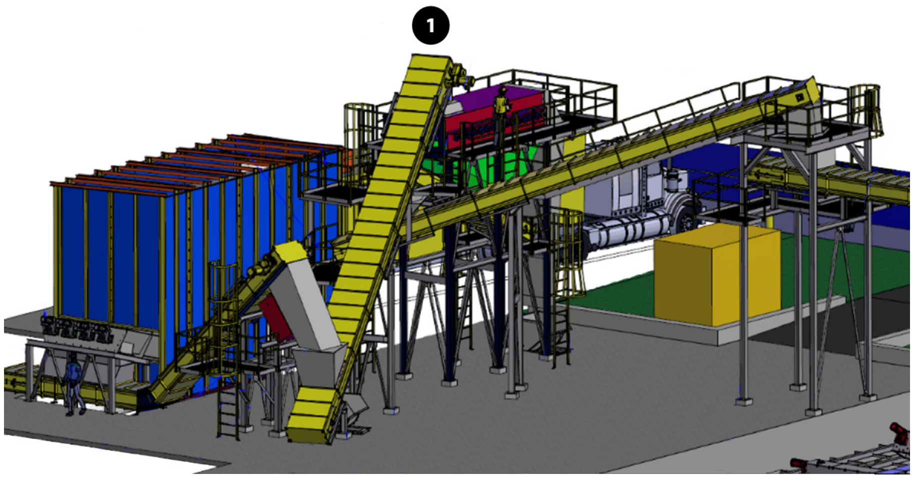
Adapted from: Seungho Han

MODIFIED FLOOR PLAN

To make room within the facility, existing equipment had to be removed. The BRIC occupies the space where the wood silo was previously located, and the new boiler system takes up the space previously occupied by decommissioned syngas cleanup equipment.

New Biomass Heat Generation System » The new BRDF biomass heat generation system features a wood waste combustion technology to directly produce thermal energy. The decision to use combustion was due to the cost effectiveness and reliability of the available technology from an operational standpoint as well as the ability to increase system capacity within the confined space limitations of the existing building.

In the new combustion system, the biomass fuel (wood waste) is transported from temporary external storage through conveyor belts and delivered to the furnace through mechanical stokers. Once in the furnace the material is ignited and burned prior to entering the 12MW capacity Grate-Fired Boiler. At the lower end of the grate all that is left is ash. Hot flue gases from the combustion process are drawn through the hot water generator where the water absorbs the heat. The hot water is then circulated through the Academic District Energy System to heat campus buildings. The flue gases are cleaned in two stages: a mechanical collector to remove large particles, and an electrostatic precipitator to remove small particles.



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BIOMASS EXPANSION ENERGY GENERATION SYSTEM

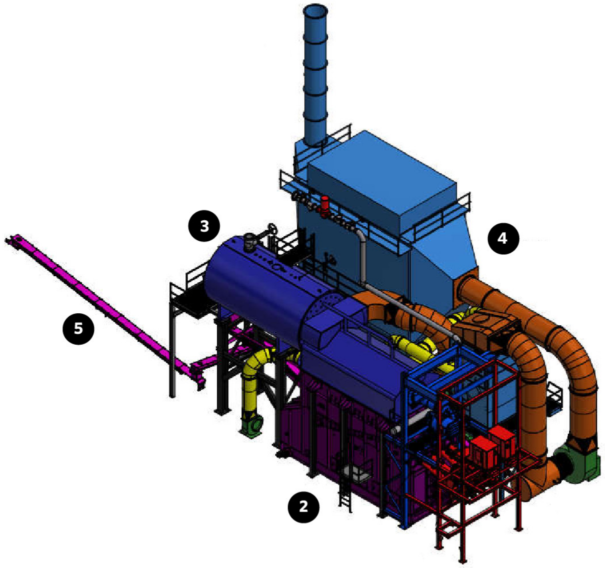
1. Wood waste is transported by the new biomass conveying system.

2. The ultra grate combustion system converts the biomass into hot flue gas.

3. Hot flue gas enters the new 12 MW boiler to produce hot water for campus heat distribution.

4. The electrostatic precipitator filters the particles in the flue gas, which is then released into the atmosphere.

5. The new ash removal system improves the boiler efficiency by removing the ash from the system.



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BRIC

BRIC

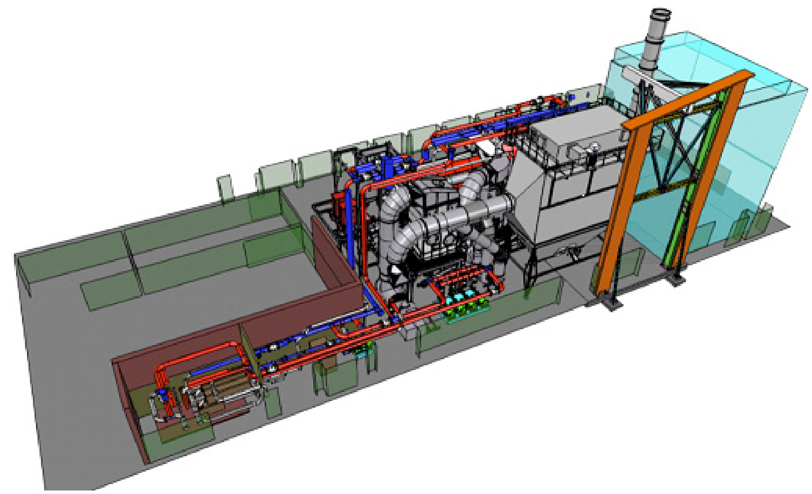
Biorefining Research and Innovation Center » As a flagship Campus as a Living Lab facility, BRDF has been supporting a substantial research program since it opened. The expansion project provided an excellent opportunity also to expand the research program with the construction of a new Biorefining Research and Innovation Centre (BRIC). This initiative was led by faculty members from two UBC faculties: Applied Science and Forestry.

The BRIC is a $7 million CAD (2017) facility funded by the Canadian Foundation for Innovation, BC Knowledge Development Fund, Pacific Economic Development Canada and UBC that enables researchers to develop new technologies and bioproducts at an industrially relevant scale. It houses advanced biomass processing reactors, lab and office space for graduate students, and a growing suite of specialized analytical equipment to assess current systems byproducts and develop new value-added bioproducts. The BRIC building is next to, but separate from the BRDF and continues to access system by-products for use in experiments.

The BRIC research program explores a wide range of topics, including gasification, pyrolysis, and chemical conversion of biomass into new biofuels and bioproducts. Since the facility's completion, BRIC researchers have successfully produced biochar, bio-oil, and syngas for use in other industrial processes. BRIC enables UBC researchers to study biochemical and thermochemical pathways for transforming the production waste from sawmills and forestry practices into fuels, chemicals, and products that offer more sustainable alternatives to fossil fuel-derived products. BRIC researchers are also collaborating with the BRDF operational team to analyze the GHG emissions profiles of novel fuel sources — demonstrating the integration of operations and applied research.

VIRTUAL DESIGN AND CONSTRUCTION (VDC) IN THE BRDF EXPANSION PROJECT

Use of VDC and Research Integration » The BRDF Expansion Project used Virtual Design and Construction (VDC) to address one of its most complex challenges: installing massive new equipment into the tight footprint of the existing facility while the adjacent BRIC building was under construction. VDC allowed the project team to plan each step with precision, anticipate installation obstacles, and coordinate activities among multiple trades and contractors before work began on site. As part of BRDF Expansion Project, UBC supported graduate research on VDC and Building Information Modeling (BIM) led by Seungho Han (UBC Civil Engineering). His 2021 thesis, Exploring Digital Project Delivery in Renovation Projects: A Case Study of UBC's Bioenergy Research Demonstration Facility Expansion Project, provides an in-depth analysis of how these tools were applied at BRDF, documenting their benefits, challenges, and lessons learned.



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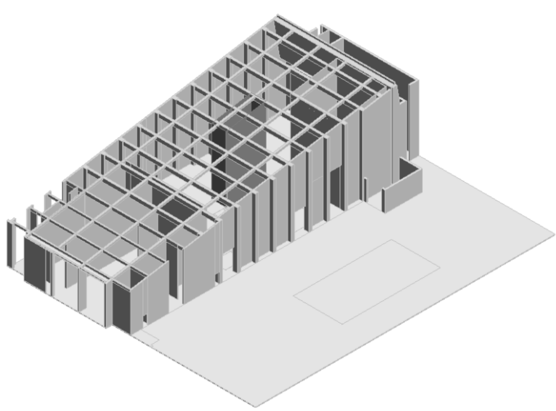
VDC & BIM

Virtual Design and Construction (VDC) is the process of utilizing computer technology to make the design and construction process more efficient. BIM is one of the tools that can be used in the VDC process.

Building Information Modelling (BIM) is a digital representation of physical and functional characteristics of a facility. The model is a shared knowledge resource that forms a reliable basis for decision-making throughout the project life cycle (NBIMS Committee).



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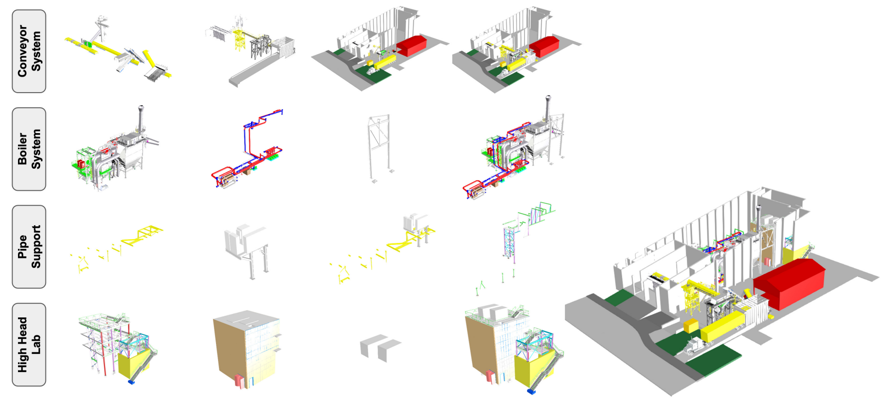
Modelling of existing structure by VDC Integrator.

VDC Application and Benefits » Through the design of the BRDF Expansion, the VDC Integrator periodically collected the different models and drawings from each consultant to develop and update a central (federated) Building Information Model (BIM) for the project. This unified model enabled the project team to visualize the final layout from multiple angles, assess how different systems would interact, detect clashes between new and existing components, and confirm that massive equipment could be moved, rotated, and installed safely within the extremely tight confines of the building. Reality capture scans of the facility generated precise as-built data, which proved essential for addressing discrepancies in older drawings—particularly for underground or hidden elements that could not be visually inspected.

The 4D modeling capability, which incorporates time into the 3D model, allowed the team to carefully plan equipment delivery routes, phased installation sequences and workspace requirements, ensuring critical steps were executed in the right order with minimal disruption to operations. This level of foresight was especially valuable given the interconnection of multiple systems and the simultaneous construction of the adjacent BRIC facility. Virtual reality walkthroughs gave engineers, operators, and maintenance staff an immersive way to "step inside" the digital model before construction, ensuring adequate clearance for safe operation, future maintenance, and emergency access.

The benefits were significant: the use of VDC reduced field coordination issues, caught design errors and omissions early, enhanced communication among designers, builders, and operators, and streamlined Requests for Information (RFIs) by enabling visual problem-solving directly in the model instead of relying solely on written exchanges. By allowing the project to be "built twice"—first digitally, then physically—VDC helped avoid costly rework, accelerated installation timelines, and provided a clear, shared pathway from design to operation, all while managing the complexities of working in an active energy facility.



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Integrated BIM structure for the conveyor system, boiler system, pipe support and high head lab into central model.

BRDF EXPANSION DESIGN AND CONSTRUCTION PROCESS

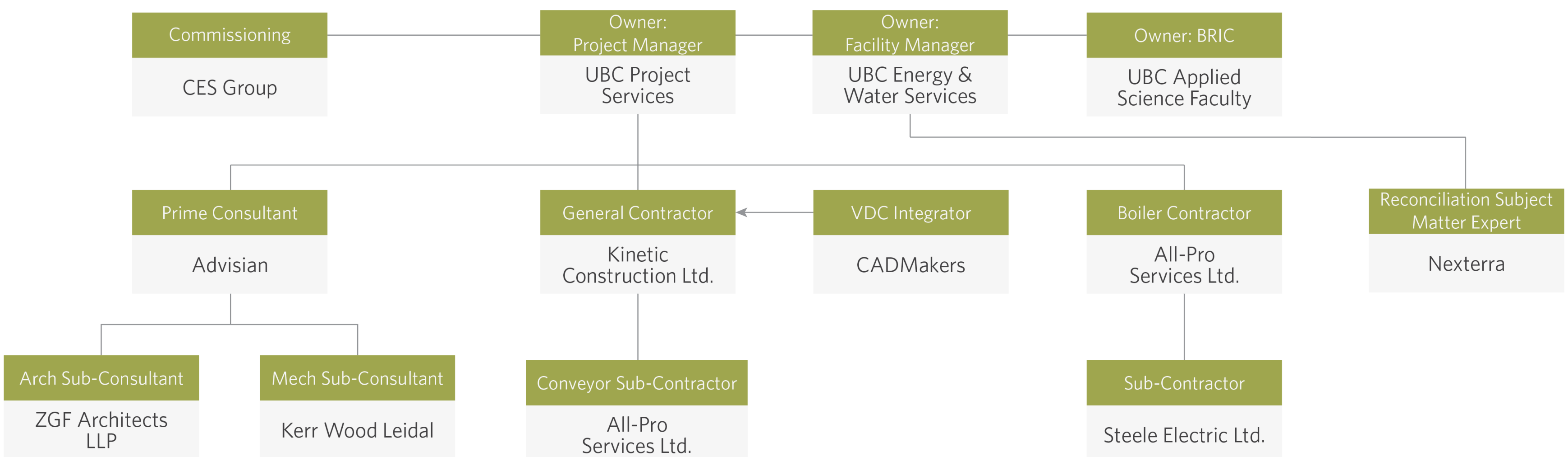
The majority of the BRDF Expansion Project followed a conventional Design-Bid-Build delivery method, including the expanded fuel delivery system, a new fuel storage bunker, a new emergency exit and additional windows in the existing building, and the new BRIC. The new combustion furnace and boiler system was delivered separately under a Design-Build contract.

Team Composition » The project involved multiple UBC units. UBC Facilities Infrastructure Developments' Project Services provided project and construction management services for the expansion project, and Energy & Water Services is responsible for the operation and maintenance of the facility once the project is completed. UBC's Faculty of Applied Science manages the BRIC on behalf of the faculty members and students using it to conduct research.

During Phase 1 of the BRDF Expansion Project, Infrastructure Developments' Project Services contracted directly with the key project team members for the design and construction of the new biomass system and expanded facility.

A prime consultant managed the design administration of the project and oversaw the architectural and mechanical design sub-consultants. The general contractor provided construction management and coordination of the construction team and sub-contracted trades. At UBC's request, the general contractor also engaged a Virtual Design and Construction (VDC) Integrator to provide Building Information Modeling (BIM) related modeling services and play a communication role throughout design and construction. Boiler supply and installation were provided by a dedicated boiler contractor who partnered with a supplier who designed and supplied the equipment.

During Phase 2 of the BRDF Expansion Project, Energy and Water Services engaged a subject matter expert to work with BRDF operation team on reconciling functional issues, and on the commissioning, optimization and systems integration.

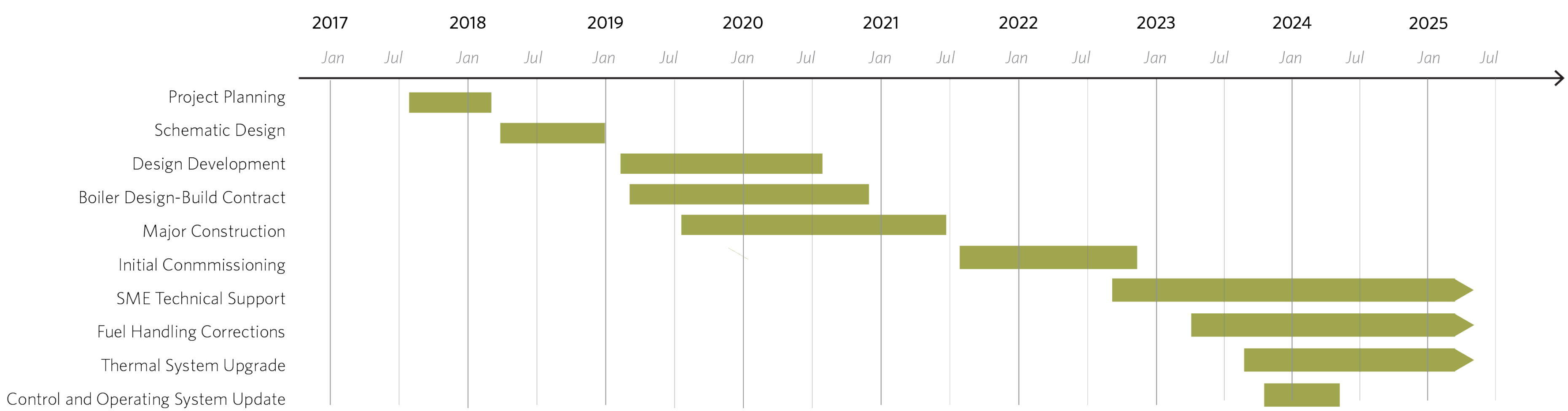


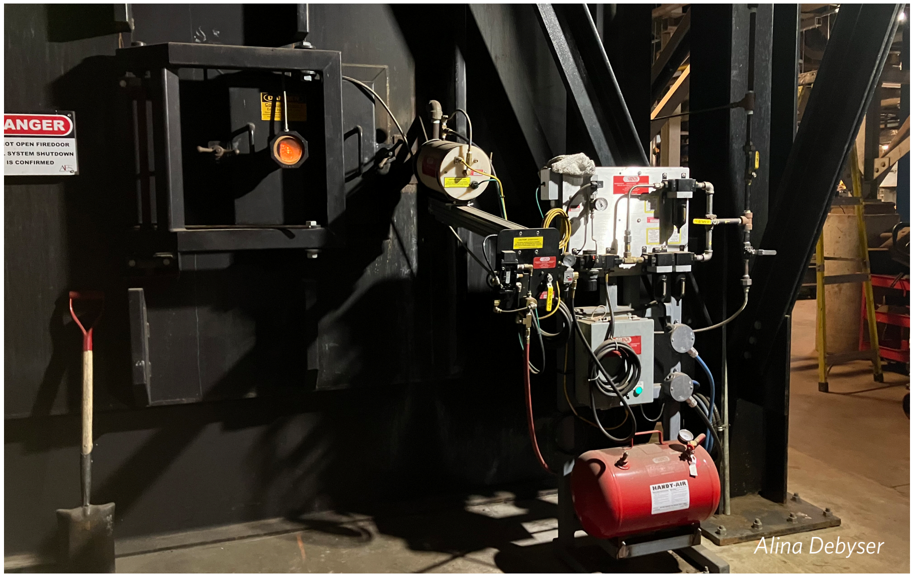
Adapted from: Seungho Han

Design and construction schedule » Planning for the BRDF Expansion Project began in September 2017, led by UBC Energy & Water Services in collaboration with Project Services. The prime consultant contract was awarded in March 2018, followed by ten months of schematic design, completed in January 2019. During this time, contracts for the general contractor and the design-build boiler supplier were also issued and awarded. Design development began in February 2019 and concluded in August 2020, alongside the award of development and construction permits.

Construction began in August 2019 with the removal of the original gasification equipment. Over the next two years, the expanded fuel handling systems, new conveyors, and the grate-fired boiler were installed. The commissioning process for the facility started in August 2021, shortly after installation of the conveying system and lasted for over a year before it had to be suspended due to challenges with the specified equipment and overall design.

In mid-2023, the project entered a reconciliation and optimization phase to address these deficiencies, improve system integration, and stabilize operations. Over 2023 and 2024, targeted equipment replacements, control upgrades, and process adjustments were implemented to bring the new systems in line with operational requirements. By early 2025, the BRDF Expansion Project was complete, and the BRDF achieved its intended capacity providing the full of 19MW thermal energy for the Academic Distric Energy System.





Alina Debyser

Alina Debyser

SYSTEM RECONCILIATION: COMMISSIONING AND POST-INSTALLATION OPTIMIZATION

When the initial construction and installation wrapped up in early 2023, the expanded BRDF systems were operating but not achieving the intended thermal energy output and key systems were not working together as designed. The rate of fuel delivery to the boiler was inconsistent, some components were prone to mechanical issues, and the limited ability of the control systems to monitor and adjust system performance in real time were creating functional challenges. As a result, the new BRDF energy generation system could not sustain operation and overall reliability fell short of the long-term requirements.

The following reconciliation phase, which included commissioning and systems optimization, became a necessary step to realize the BRDF Expansion Project's goals. The focus was on diagnosing system limitations, reconfiguring underperforming components, and giving operators the tools to run the BRDF efficiently at full output. UBC engaged Nexterra, the subject-matter expert for the original biomass gasification system, to work alongside Energy & Water Services staff in planning and executing these improvements.

Major Equipment Update and Thermal System Reconfiguration » In 2023, boiler performance was constrained by uneven combustion, limited temperature data, and restricted visibility into the furnace. These gaps made it harder for operators to fine-tune the system or quickly respond to changing conditions.

Key upgrades addressed these constraints:

- Enhanced monitoring: cameras and inspection ports were added to provide real-time visibility into furnace conditions.
- Better temperature tracking: additional thermocouples were installed to monitor heat distribution and guide operational adjustments.
- Control system overhaul: boiler control programming was redesigned to improve grate movement, fuel feed rates, and airflow management.

These measures improved combustion stability, increased heat transfer efficiency, and gave operators more direct control over performance.

Fuel Handling and Conveyor System Overhaul » Fuel handling was another critical bottleneck in 2023. The conveyors moving biomass from the truck unloading station to the fuel bay could not consistently meet the required feed rates, and certain components were overly susceptible to wear and blockages.

Upgrades completed during the reconciliation phase included:

- Conveyor replacements: several units were replaced or reconfigured to improve throughput and system integration.
- Improved screening: the biomass screening magnet was replaced with a more robust model to better protect downstream equipment.
- Offloading screw modifications: storage bay's screw conveyors were redesigned to improve filling patterns and reduce jams.

These changes improved fuel flow consistency, reduced the need for manual intervention, and helped ensure the plant could meet its daily throughput targets without frequent stoppages. By early 2025, these combined improvements in boiler systems and fuel handling enabled the BRDF to achieve its full design capacity with greater operational consistency.

FUTURE-PROOFING OPERATIONS AND FUTURE OPTIMIZATIONS

With BRDF now delivering the full thermal energy and electrical output, the focus has shifted to ensuring long-term reliability, efficiency, and adaptability—critical for meeting future campus heating demands as UBC grows.

Current Operations of BRDF » The operational stability of complex energy generation systems, like BRDF, depends on skilled staffing and robust maintenance systems. The BRDF team now includes a Chief Engineer, an Assistant Chief Engineer (ACE), five rotating shift engineers with assistants, and two relief positions to ensure continuous and consistent operations without overloading team members. The ACE also manages a preventive maintenance system integrated with other UBC operational platforms for standardized asset tracking and coordination of operational and maintenance work across trades on campus.

Trades support for BRDF was strengthened by the hiring of two thermal millwrights to handle inspections, mechanical repairs, and system adjustments internally. Adding this expertise internally increases the capacity base with Energy and Water Services, reduces UBC reliance on external vendors, and shortens the timeline for repairs and maintenance. A standing contract with a subject-matter expert Nexterra continues to provide targeted technical support, ensuring ongoing operational improvements are maintained and refined.

Planned Upgrades for Thermal Optimization and Campus Resilience » Following the completion of the BRDF Expansion project, UBC is now looking at targeted upgrades to further increase efficiency, resilience, and adaptability of the systems. These include an upgrade to a higher-capacity, more durable biomass and ash conveying system, as well as additional equipment to capture more waste heat from the boiler and flue gases, and redistribute it to the Academic District Energy System.

Alina Debyser

LESSONS LEARNED FROM THE BIOMASS EXPANSION PROJECT

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BRDF EXPANSION PROJECT CHALLENGES AND LEARNING

The BRDF Expansion Project was a complex, multi-year initiative that combined conventional construction with the integration of new industrial energy systems, all within an operating energy generation facility. Across both the original design, construction (Phase I) and the post-installation reconciliation (Phase II), the project revealed valuable lessons in project delivery, coordination, commissioning, and operations. These insights provide a valuable foundation for guiding future district energy projects, particularly those undertaken by institutions that must balance innovation, operational continuity, and academic integration.

Challenges with the project delivery » BRDF Expansion Project utilized a hybrid project delivery model: a Design-Bid-Build contract for most expansion activities and a separate Design-Build contract for the new grate-fired boiler system. While this approach offered greater cost certainty and allowed specialized procurement of the boiler, it also introduced complexity in team roles, communication, and accountability. The separation between contracts created additional coordination challenges, as design changes in one scope often had implications for the other. The hybrid approach also reduced flexibility to reassign or integrate responsibilities between teams when unexpected issues arose, which in turn slowed resolution timelines.

The experience underscores the importance of ensuring early and integrated input from and alignment of all project teams, whether through contractual or process-based measures and maintaining a unified project execution framework. Equally, it highlighted the value of recruiting and engaging in-house thermal trades, possessing direct thermal plant expertise, earlier in the process and building stronger mechanisms for integrating operator and thermal team feedback into design and delivery.

Discrepancies in as-built information » One of the key benefits of using VDC modelling in this project was the creation of an accurate as-is model of the facility before expansion. While reality capture provided highly accurate geometric data for visible components, it could not detect elements hidden behind walls or floors. For those, the team relied on existing as-built drawings, which contained inaccuracies for some underground ducts and concealed piping, leading to scope changes and delays. Future projects would benefit from more extensive pre-construction verification of critical concealed systems to avoid downstream conflicts.

Challenges during construction and commissioning » Maintaining partial operation of BRDF during the project required complex phasing and constant coordination between construction crews and Energy & Water Services staff. Equipment installation and system integration schedules had to be adapted to avoid interruptions of service to the operating system and of energy to Academic District Energy System, which added logistical complexity.

When commissioning began, several systems failed to meet performance expectations, preventing the BRDF from producing the intended amount of thermal energy, and integration between new and existing systems revealed unforeseen compatibility gaps. In addition, omitting critical industry-standard equipment and tools, such as furnace cameras, during the initial build limited operators' ability to monitor vital operational and safety parameters such as

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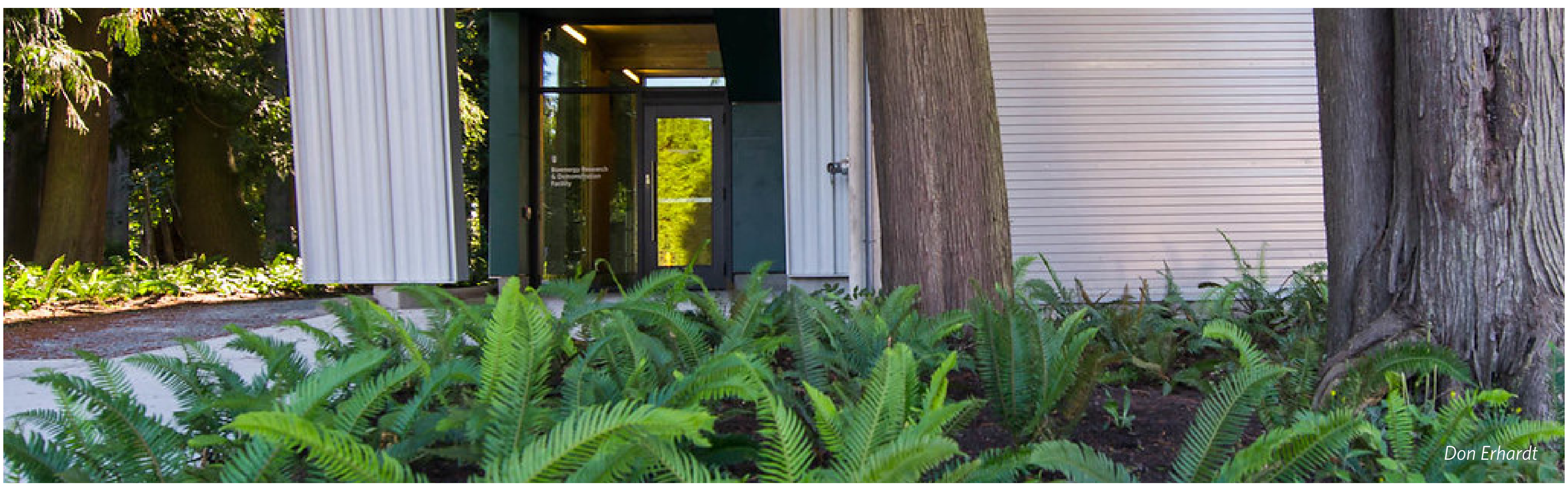
combustion conditions and furnace operation in real time. These challenges required extended troubleshooting, redesign, and equipment replacement during the Phase II reconciliation phase.

The project reinforced the importance of commissioning as a structured, sequential, empirical process—testing and addressing each component and then the integrated system—rather than relying primarily on qualitative, post-installation assessments.

Operational Readiness and Insights » One of the key learnings from the project was the importance of aligning UBC's design and strategic approach more closely with established industry benchmarks for thermal utility and generation plants—particularly in the areas of application-specific equipment selection, performance monitoring, and commissioning. Thermal plants also require dedicated process and operational support through specialized staff such as an Assistant Chief Engineer, Process Engineer, or Operations Specialist. During the remediation phase, contractor surrogates were engaged to provide this process and operational expertise until internal support became available.

Addressing QA/QC System Gaps » The project highlighted a lack of formalized Quality Assurance/Quality Control (QA/QC) processes for industrial-scale systems at UBC. While QA/QC was addressed contractually, enforcement and oversight were inconsistent, and commissioning documentation varied in completeness. Also, the absence of an essential thermal performance monitoring system during installation, commissioning, and operation limited the team's capability to empirically track progress, performance and reliability, or to guide equipment selection and adjustments against industry benchmark performance standards. Post-expansion efforts have focused on strengthening QA/QC protocols, implementing structured deficiency walkthroughs, and requiring full documentation handover and operator training before acceptance. These measures are planned to be applied to future BRDF and other infrastructure projects to ensure more robust system delivery.



Capacity Building & Training » Handover and training proved critical to long-term operational success. Without complete documentation and hands-on instruction from installers, Energy & Water Services staff faced steeper learning curves and higher risk of errors. A key learning from the expansion was the importance of having dedicated thermal millwright support and timely access to internal trades with experience in thermal industrial systems. Involving this expertise earlier would have accelerated and improved troubleshooting, reduced reliance on external contractors, and provided stronger operational support during commissioning. Building on these lessons, Energy & Water Services has expanded the BRDF team to include better process and operational expertise. The BRDF team has since implemented a formal training and tracking system, supported by the Chief Engineer, to ensure that future equipment installations include thorough onboarding and operational readiness before final acceptance.

Reporting & Communication Systems » A lack of standardized reporting to UBC Energy & Water Services was identified during the expansion, which limited visibility and slowed coordination. This gap has since been addressed through structured monthly business reviews, performance summaries, and real-time operational dashboards. These tools now support clearer decision-making, greater transparency, and more effective alignment across operational and leadership teams. Equally important, the project highlighted the value of stronger feedback loops so that operator insights and on-the-ground experience are consistently captured and acted upon. Embedding these practices ensures that “learning effects” are shared across all stakeholder groups, helping the whole team learn as a unit while directly informing training, commissioning, and ongoing system optimization.

Benefits and Challenges of VDC & BIM » VDC and BIM proved essential for managing the BRDF Expansion Project’s spatial and logistical complexity, but their mid-project introduction—without early, project-wide requirements or a BIM execution plan—led to inconsistent integration across design teams, non-standard deliverables, and missed opportunities for full collaboration. Limited VDC experience among some team members also reduced the model’s potential for coordination, clash detection, and decision-making. Contractual arrangements that placed the VDC Integrator under the general contractor, rather than directly with UBC or design consultants, slowed data exchange and limited cross-discipline collaboration. In some cases, expanding the model’s use incurred additional costs, discouraging teams from leveraging it to its fullest potential.

For future projects, these challenges point to the value of defining VDC scope and objectives from the outset, establishing BIM standards early, engaging practitioners with proven experience, and structuring contracts to encourage seamless collaboration, direct data sharing, and shared accountability across all delivery partners.

Don Erhardt

CONCLUSION

As a Campus Living Lab project, the design, construction, commissioning, optimization and operation of BRDF systems are a source of learning for UBC and others. In order to respond to the climate emergency and meet GHG emission reduction targets, institutions and governments are looking at innovative technologies to support and expand their energy infrastructure. These systems and technologies can be challenging to develop, install and operate. By documenting and sharing the processes and lessons learned from the BRDF expansion project, UBC seeks to help other organizations implementing similar utilities, and accelerate global progress in emissions reduction.

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