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Sustainable Architecture Conductor: The Centre for Interactive Research on Sustainability

Climate change is a real and immediate concern, as it threatens the existence of life on earth.¹ However, the assumption that it cannot be 'remedied' is preposterous, since there are plenty of reasons to be optimistic about the future of the planet. One reason, is the push for sustainable, high-performance, communal, and collaborative buildings.² These buildings promise to help undo the climate problems caused by humans, as they raise public awareness about the climate change problem and give people possible sustainable architectural solutions.³ There are a number sustainable architecture certifications and competitions which are driving college administrations to hire architects. Their objective is to make sustainable architecture advancements in an attempt to attract ambitious and environmentally conscious students and faculty members.⁴ Two well-known, respected, and challenging sustainable architecture 'contests' are the LEED accreditation system and the Living Building Challenge. The University of British Columbia's Centre for Interactive Research on Sustainability (CIRS) is one building that has taken-on both of these tests. It already won the LEED platinum certification (the highest LEED certification available) and it is pursuing completion of the multipart Living Building Challenge.⁵ The CIRS' purpose is to "test sustainable building strategies and accelerate their adoption into urban development".⁶ Ever since its introduction in November 2011, the CIRS has set new standards for sustainable buildings and has revolutionized the process of weaving sustainable architecture and education together.⁷ By reducing reliance on materials that harm the

earth, educating the public about sustainable architecture, and creating an open dialogue with other research groups, the CIRS is taking great strides to: push sustainability in architecture forward, and enlist the public in the fight to save the planet.⁸ The CIRS is globally recognized as: (1) largely self-sufficient, (2) a successful net-positive energy building, (3) a public 'teaching tool', and (4) a sustainability research institute. Its stature can be attributed to its formal qualities, its technological sustainable features, and its engagement with individuals and communities.⁹

The CIRS is located on the University of British Columbia's (UBC) Point Gray Campus in Vancouver, British Columbia, Canada.¹⁰ The building was designed by the architecture firm Perkins + Will.¹¹ The UBC's administration intended for the CIRS "to be the most innovative and high performance building in North America at the time of its opening".¹² Perkins + Will and the UBC administration succeeded at this intention through-and-through. The "61,000" square-foot, four-story building is u-shaped and is positioned on the site, so that the two expansive window facades face the North and South cardinal directions-maximizing solar collection, daylighting, and shading (See Number 1 on Image 1).¹³ Upon entering the building (on the first floor), one can pick-up-on the building's goal of being sustainable. Maybe it is the mixed exterior cladding, made-up of: stained cedar panels (which appear to have a rusty-orange coloring), the 'chalky' white brick, and the abundance of glass, which attribute the CIRS' earthy and 'au naturale' visual feel (See **Photo 1**).¹⁴ Or maybe it is the horizontal overhangs covered in 'not so subtle' photovoltaic solar panels (for electricity and shading), and the vertical fin 'trellises' (which have vines growing on them in the summer months) (See Image 2).¹⁵ Either way, visitors can tell that the building is sustainable purely by its aesthetics.

As if the exterior did not the make the building's emphasis on sustainability blatant enough, Perkins + Will decided to place the main sustainability attraction, the Solar Aquatic Lab (a "wastewater-reclamation" area), next to the entrance of the building (See **Number 7** on **Image 3**).¹⁶ The lab is full of wastewater-filled tanks, with plants living inside them (See **Photo 2**). After checking-out the Solar Aquatic Lab, visitors can quickly walk to the main portion of the building. Awaiting them is a cavernous atrium, which proves to be a stunning experience (See **Photo 3**) (See **Number 1** on **Image 3**). A skylight in the roof covers the atrium space in a generous amount of glittering light.¹⁷ The atrium separates the two wings of building and exposes the bustling students and faculty, hurriedly moving up-and-down the four floors, like tiny ants. Pine wood, the primary material used on the building, makes-up the wooden 'skeleton' that helps hold-up the building.¹⁸ The frame is clearly visible in the atrium space, which once again reminds visitors that the building is sustainable. The secondary materials used in the interior space include: "glulam members, dimensional lumber, plywood, and concrete".¹⁹ From the atrium, occupants can venture to: (1) the Modern Green Auditorium, (2) the Loop Café, and/or (3) the upper floors with classrooms and offices.²⁰

The Modern Green Auditorium's seats over 400 students and has an adjoining theatre, called the BC Hydro Theatre, for smaller break-out presentations (the auditorium is **Number 2** and the theatre is **Number 6** on **Image 3**).²¹ The auditorium's defining feature is its arched ceiling made of pine wood, which resembles the ribs of a ship, and encapsulates the audience (creating a cozy milieu) (See **Photo 4**).²² A green roof is positioned directly above the auditorium and is an ecosystem for local wildlife.²³ The upper floors (from floor two to floor four) revolve around the green roof, which supplies people on the upper floors with views of the greenery (on the green roof) and daylight (which helps with their well-being, health, and productivity) (See **Photo 5**).²⁴ The floor plan layouts and walls are purposefully airy and modular, to allow the faculty to readapt the spaces (i.e. updating them with superior equipment),

to better suit the needs of the students and their research.²⁵ While many of the aforementioned formal qualities help contribute the CIRS' sustainability, they are generally more aesthetic and visual in nature, when compared to the deeper, underlying architectural sustainability features at work.

Not only is the Solar Aquatic Lab aesthetically fascinating, it is also technologically innovative. In essence, the lab takes 'what would be' dirty wastewater and filters it through a complex system of plants in massive vats, to purify it-removing the dirty impurities and making it reusable.²⁶ This creates an infinite recycling cycle which is both highly effective and eco-friendly. The orientation, vast amount of windows, u-shaped form, green roof (which doubles as a light well), and skylights provide all rooms with daylight and reduce the need electrical lighting during the day.²⁷ Lights with built-in motion sensors are installed in each room, and shut-off if the conditions are bright enough and/or if there are no occupants in a room—lessening electrical consumption costs.²⁸ All of the windows are triple paned and have a low-e coating on them to reduce the amount of ultraviolet light from entering the building and reduce glare.²⁹ As a result, the relative humidity stays higher in the winter, thereby reducing condensation (which can lead to mildew and efflorescence) and the occupant comfort is not impeded.³⁰ A majority of the windows on the building are operable, allowing people to open them to create passive ventilation (which helps heat and dry-out moist spaces).³¹ The atrium space is similar in nature.

The atrium is large enough that it allows air to circulate the spaces (through the convection process) allowing for passive ventilation.³² The main building frame, the atrium space framing, and ceiling in the Modern Green Auditorium are made primarily of locally-sourced pine beetle-infected wood—an inventive and effective reuse of a material that might

normally get deemed as unusable and unsafe.³³ The pine wood and cedar cladding stores approximately "600" metric tons of carbon dioxide, the equivalent to the carbon dioxide emittance of "128 passenger vehicles driven" annually-clearly reducing the CIRS' carbon dioxide emissions.³⁴ The wood usage also brings to mind a paper on architectural sustainability, written by two sustainability experts, Simon Guy and Graham Farmer. Specifically, the concept of using locally-sourced and recycled materials for construction-deemed the 'eco-cultural logic' by the two authors.³⁵ Buildings that embody this 'logic' need to embrace the existing environment and use local materials, to better complement with surrounding architecture.³⁶ A building like the CIRS, exemplifies this logic and begins to meet the requirements for both LEED Platinum certification and Living Building Challenge accreditation.³⁷ The green roof (with trees) and green wall with its deciduous vines, improve shading in the hot summer months and allow for sunlight in the winter (when the flora drop their leaves)-reducing cooling and heating costs.³⁸ The building is equipped with a rainwater collection system (with an underground cistern), which is reused as "potable water" on the green roof to grow plants.³⁹ The CIRS is integrated with the Earth and Ocean Sciences Building and the entire UBC campus in a closed-loop heating system, where the building takes-in energy and then redistributes it.⁴⁰ This heating system integration, plus the UBC campus' hydroelectric power plant, along with the CIRS' other sustainability features, means that the CIRS takes-in "585 [megawatt hours] per year" and "returns 600 [megawatt hours back to the campus] annually".⁴¹ Leading to the netpositive energy usage, where the building produces more energy than it takes in. While the sustainability features above are great, their value would be partly diminished if it was not for the sensors and monitoring equipment which are synced with many of the sustainable features. These sensors assist students and faculty in finding problems with the building. Ironically none

of the building components with sensors with have failed, but the water collection system (with no sensors) malfunctioned—putting the Living Building Challenge on-hold.⁴² The sustainability data from the sensors is also displayed in the atrium space, for all to see.⁴³ This 'transparent' approach and public broadcasting of statistics (which might stay undisclosed), is a means of outreach and a catalyst for environmental change.

A give-and-take dialogue/learning with individuals and communities is a key aspect of the philosophy at the CIRS. This dialogue generated by the CIRS' students and faculty relates to two logics proposed by Simon Guy and Graham Farmer; the eco-technic logic and the eco-social logic.⁴⁴ As its name implies, the eco-technic logic has to do with technology, particularly the implementation of the latest sustainable architectural technologies in buildings.⁴⁵ The students and faculty at CIRS are constantly experimenting with new technologies, and educating the public with them. For example, the Solar Aquatic Lab's inner workings are exposed to public, to help them see and learn about one of the more state-of-art and tangible sustainable technologies in-use at the building.⁴⁶ The sensor and monitoring system that reports-out data on energy usage is inescapable. In his article "Tapping the Trash," Michael Webber claimed that cities should share energy consumption with their inhabitants, to force them to reexamine their waste and energy-spending habits.⁴⁷ While the CIRS is not a city, the energy consumption data is proving to be useful, as it forces occupants to confront the positives and negatives of the CIRS on a daily basis—making them better-informed. The atrium has countless computer displays, which describe the sustainability features to visitors, once again helping educate the public about the sustainability features at play.⁴⁸ The academic research component on sustainable architecture at the CIRS, could be associated with the eco-social logic, because some of the architectural

sustainability efforts are focused less on "individual learning" and more on an ever-evolving global body of learning.⁴⁹

The CIRS' students share their results and guidance with other sustainability institutes and get new ideas from international students and professionals (in an ongoing collaborative process)—to quicken advancements in sustainable architecture (and begin to undo climate change at a larger level).⁵⁰ An instance of this guidance, is the "Performance Gap Program", in which students interface with institutions and architecture firms in North America and educate them and help them overcome sustainable architecture hindrances.⁵¹ The CIRS' shares similarities and differences with two other buildings, which attempt to teach the public about architectural sustainability too.

The Hitchcock Center at Hampshire College (in Amherst, Massachusetts) has a similar understated, earthy, and woody aesthetic, with prominent timber beams on the exterior and interior—exposed to onlookers. This building material choice helps the building fit in with the surrounding rural, vernacular architecture (consisting of old wooden barns and houses made of stained timber). Because the Hitchcock Center is connected to Hampshire College, it shares the CIRS' commitment to educate both the general public and the students. Like CIRS, the Center has exposed sustainability systems and accompanying signage, which helps explain the processes at work.⁵² In addition, most of the sustainable mechanisms have sensors on them, which allows students to learn from the Center and make improvements.⁵³ Where the buildings really differ is in their scale. The Center has only two floors (one above ground and one below) and a relatively small 'footprint' of "9,000 square feet", making the CIRS massive in comparison.⁵⁴ The smaller gross square footage means that there is less space to heat and cool, and means that the Center can have fewer sustainable features (because they would be unnecessary for such a small

building). If The Hitchcock Center represents a version of the 'modest and unpretentious sustainable educational building of the future', then Bjarke Ingels Group's (BIG) Amager Bakke waste incinerator architecture in-progress project in Copenhagen, Denmark is its polar opposite-making the CIRS an educational sustainable building at the 'middle of road' (See Image 4).⁵⁵ Like the CIRS and the Hitchcock Center, the goal of project is to educate the public and raise public awareness about sustainable architecture. Unlike the CIRS and the Hitchcock Center, BIG's incinerator will take an unorthodox approach to teach the public, opting to avoid the use signs, in favor of spectacle and flashiness.⁵⁶ For instance, the chimney on the incinerator splits out apocalyptic, ominous carbon dioxide smoke rings which are visible from all over Copenhagen, causing people critically examine their impacts on the environment.⁵⁷ Additionally, a ski slope, climbing wall, and green roof act to attract people the incinerator and make mixed used building, that brings people together—possibly leading to further conversation about the environmental problems.⁵⁸ The CIRS might not have the 'eye-candy' and outer charm that the incinerator has, but its sustainability features are superior (as the incinerator does not have the sustainable features to help it get LEED certification or compete in the Living Building Challenge). Despite this major difference, the CIRS can learn from the incinerator plant and become the international hub of sustainable architecture advancement and education.

The CIRS is an epicenter for sustainable architectural education at UBC and is making a difference, but there is one catch. It could make *more* of a difference. The main visitors and tourists at the CIRS are students and prospective students. Sure, the CIRS' connections and programs with other research groups are a great way to make architectural sustainability progress, but relatively speaking, the CIRS is cut-off the larger population—who is unaware of the architectural sustainable technologies that the CIRS is testing. The larger population is a key

piece in saving the planet and needs to be included in the collaboration of sustainable architecture ideas. This is where BIG's upcoming incinerator project can help inspire the CIRS and provide the CIRS' administration with ideas for getting the general public to the building. One solution is to create a public lecture series in the Modern Green auditorium space, with wellknown scholars, to increase the turn-out of non-students visiting the building (thereby increasing awareness levels). Another solution is to readapt some of the spaces with the modular dividers, to create a public museum or workshop area that better immerses visitors in the CIRS' sustainability practices. These two ideas, coupled with other 'attractions' could make the CIRS a marvel—expanding its visitor 'count' and its conductance. Its revolutionary, super-charged ideas would rapidly permeate the globe and accelerate architectural sustainability innovations, creating a lasting impact on humanity and planet earth.

Appendix

- **Image 1:** The CIRS Site Plan
- Photo 1: Exterior view of the Southern and Eastern facades of the CIRS
- Image 2: Exterior view of the deciduous vines on the Southern façade of the CIRS
- **Image 3:** The CIRS First Floor Plan
- **Photo 2:** The CIRS' Solar Aquatic Laboratory
- Photo 3: A view of the CIRS' interior atrium space
- Photo 4: The Modern Green Auditorium at the CIRS
- **Photo 5:** The green roof at the CIRS
- Image 4: BIG's Amager Bakke waste incinerator



Image 1: The CIRS Site Plan⁵⁹



Photo 1: Exterior view of the Southern and Eastern facades of the CIRS⁶⁰



Image 2: Exterior view of the deciduous vines on the Southern façade of the CIRS⁶¹



Image 3: The CIRS First Floor Plan (referred to as the "Ground Floor" by Perkins + Will)⁶²



Photo 2: The CIRS' Solar Aquatic Laboratory⁶³





Photo 3: A view of the CIRS' interior atrium space⁶⁴



Photo 4: The Modern Green Auditorium at the CIRS⁶⁵



Photo 5: The green roof at the CIRS⁶⁶



Image 4: BIG's Amager Bakke waste incinerator⁶⁷

Endnotes

¹ NGO Committee on Education, comp, "Our Common Future, From One Earth to One World," http://www.un-documents.net/ocf-ov.htm#I.1.

² Guy, Simon, and Graham Farmer, "Reinterpreting Sustainable Architecture: The Place for Technology," In *Journal of Architectural Education*, 140.

³ Guy, Simon, and Graham Farmer, "Reinterpreting Sustainable Architecture: The Place for Technology," In *Journal of Architectural Education*, 140.

⁴ Neuman, David, "Design Shaping the 21st Century College Camp," 1-3.

⁵ Construction Today Magazine, "Centre for Interactive Research on Sustainability,"

Construction Today, http://www.construction-today.com/90-print/canadian/469-centre-for-interactive-research-on-sustainability.

⁶ Cayuela, Alberto, and Angelique Pilon, "Test Lab for Sustainability," *High Performing*

Buildings, Spring 2015, 34. PDF.; "Centre for Interactive Research on Sustainability / Perkins + Will."

ArchDaily. https://www.archdaily.com/343442/centre-for-interactive-research-on-sustainability-perkins-will. ⁷ "Centre for Interactive Research on Sustainability," Green Building Brain,

http://greenbuildingbrain.org/buildings/centre_for_interactive_research_on_sustainability.

⁸ Cayuela, Alberto, and Angelique Pilon, "Test Lab for Sustainability," *High Performing Buildings*, Spring 2015, 34-43. PDF.;

"Is This North America's Greenest Building?" ThinkProgress. https://thinkprogress.org/is-this-north-americas-greenest-building-b570d55ae126/.

⁹ Cayuela, Alberto, and Angelique Pilon, "Test Lab for Sustainability," *High Performing Buildings*, Spring 2015, 34-43. PDF.;

"LEED Spotlight: UBC's LEED Platinum Centre for Interactive Research on Sustainability,"

https://www.cagbc.org/Archives/EN/Leed_Project_Spotlight/November_2013_Centre.aspx.; The University of British Columbia. "Research Portfolio." Centre for Interactive Research on Sustainability.

http://cirs.ubc.ca/research/regenerative-neighbourhoods/.

¹⁰ "Centre for Interactive Research on Sustainability / Perkins + Will,"

https://www.archdaily.com/343442/centre-

for-interactive-research-on-sustainability-perkins-will.

¹¹ "University of British Columbia, The Centre for Interactive Research on Sustainability (CIRS)." Perkins + Will. Accessed December 8, 2017. http://perkinswill.com/work/the-centre-for-interactive-research-on-sustainability-cirs.html.

¹² Cayuela, Alberto, and Angelique Pilon, "Test Lab for Sustainability," *High Performing Buildings*, Spring 2015, 37. PDF.

¹³ Cayuela, Alberto, and Angelique Pilon, "Test Lab for Sustainability," *High Performing Buildings*, Spring 2015, 37-38. PDF.;

"UBC Centre for Interactive Research on Sustainability." Design Build Network.

https://www.designbuild-network.com/projects/ubc-centre-for-interactive-research-on-sustainability/. ¹⁴ "2013 Wood Design Awards - Project Fact Sheet Centre for Interactive Research on Sustainability,"

http://wood-works.ca/wp-content/uploads/2013/12/recipients4-GreenBuildingAward.pdf.

¹⁵ "Centre for Interactive Research on Sustainability / Perkins + Will,"

https://www.archdaily.com/343442/centre-

for-interactive-research-on-sustainability-perkins-will.

¹⁶ Cayuela, Alberto, and Angelique Pilon, "Test Lab for Sustainability," *High Performing Buildings*, Spring 2015, 41. PDF.

¹⁷ "CIRS Virtual Tour," https://www.youvisit.com/tour/cirs.website/89506.

¹⁸ The University of British Columbia. Building Systems Manual. Centre for Interactive Research on Sustainability.

https://cirs.ubc.ca/building/building-manual/project-design/.

¹⁹ "2013 Wood Design Awards - Project Fact Sheet Centre for Interactive Research on Sustainability," http://wood-works.ca/wp-content/uploads/2013/12/recipients4-GreenBuildingAward.pdf. ²⁰ "CIRS Virtual Tour," https://www.youvisit.com/tour/cirs.website/89506.

²¹ Construction Today Magazine, "Centre for Interactive Research on Sustainability."

²² Cayuela, Alberto, and Angelique Pilon, "Test Lab for Sustainability," High Performing Buildings, Spring 2015, 38. PDF.

²³ Cayuela, Alberto, and Angelique Pilon, "Test Lab for Sustainability," High Performing Buildings, Spring 2015, 38. PDF.

²⁴ "Centre for Interactive Research on Sustainability / Perkins + Will,"

https://www.archdaily.com/343442/centre-

for-interactive-research-on-sustainability-perkins-will.; "CIRS Virtual Tour."

https://www.youvisit.com/tour/cirs.website/89506.

²⁵ Cayuela, Alberto, and Angelique Pilon, "Test Lab for Sustainability," High Performing Buildings, Spring 2015, 35. PDF.

²⁶ "UBC Centre for Interactive Research on Sustainability," https://www.designbuild-

network.com/projects/ubc-centre-for-

interactive-research-on-sustainability/.

²⁷ "2013 Wood Design Awards - Project Fact Sheet Centre for Interactive Research on

Sustainability," http://wood-works.ca/wp-content/uploads/2013/12/recipients4-GreenBuildingAward.pdf.

²⁸ Cayuela, Alberto, and Angelique Pilon, "Test Lab for Sustainability," *High Performing Buildings*, Spring 2015, 36. PDF.

²⁹ The University of British Columbia. Building Systems Manual, https://cirs.ubc.ca/building/buildingmanual/project-design/.

³⁰ Cayuela, Alberto, and Angelique Pilon, "Test Lab for Sustainability," High PerformingBuildings, Spring 2015, 38. PDF.

³¹ The University of British Columbia. Building Systems Manual, https://cirs.ubc.ca/building/buildingmanual/project-design/.

³² Cayuela, Alberto, and Angelique Pilon, "Test Lab for Sustainability," High Performing Buildings, Spring 2015, 38. PDF. ³³ "2013 Wood Design Awards - Project Fact Sheet Centre for Interactive Research on

Sustainability," http://wood-works.ca/wp-content/uploads/2013/12/recipients4-GreenBuildingAward.pdf. ³⁴ "UBC's Centre for Interactive Research on Sustainability." Video file, 01:45. YouTube. Posted by

University of British Columbia, November 2, 2011. https://www.youtube.com/watch?v=dzNZO7WXBw4.; United States Environmental Protection Agency. "Greenhouse Gas Equivalencies Calculator." United States Environmental Protection Agency.

https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator.

³⁵ Guy, Simon, and Graham Farmer, "Reinterpreting Sustainable Architecture: The Place for Technology," In Journal of Architectural Education, 144.

³⁶ Guy, Simon, and Graham Farmer, "Reinterpreting Sustainable Architecture: The Place for Technology," In Journal of Architectural Education, 144.

³⁷ "LEED Spotlight: UBC's LEED Platinum Centre for Interactive Research on Sustainability."

https://www.cagbc.org/Archives/EN/Leed Project Spotlight/November 2013 Centre.aspx.

³⁸ "Centre for Interactive Research on Sustainability / Perkins + Will,"

https://www.archdaily.com/343442/centre-for-interactive

research-on-sustainability-perkins-will.; "UBC Centre for Interactive Research on Sustainability." https://www.designbuild-

network.com/projects/ubc-centre-for-interactive-research-on-sustainability/.

³⁹ Cayuela, Alberto, and Angelique Pilon, "Test Lab for Sustainability," *High Performing Buildings*, Spring 2015, 41. PDF.

⁴⁰ McDonough, William. "How Cities Could Save Us." *Scientific American*, July 2017, 44-48. PDF.

⁴¹ Cavuela, Alberto, and Angelique Pilon, "Test Lab for Sustainability," *High Performing Buildings*, Spring 2015, 37. PDF.; "UBC Centre for Interactive Research on Sustainability,"

https://www.designbuild-network.com/projects/ubc-centre-for-interactive-research-on-sustainability/.

⁴² Cayuela, Alberto, and Angelique Pilon, "Test Lab for Sustainability," *High Performing Buildings*, Spring 2015, 42. PDF.

⁴³ "Centre for Interactive Research on Sustainability / Perkins + Will,"

https://www.archdaily.com/343442/centre-for-interactive-research-on-sustainability-perkins-will.

⁴⁴ Guy, Simon, and Graham Farmer, "Reinterpreting Sustainable Architecture: The Place for Technology," In *Journal of Architectural Education*, 140-148.

⁴⁵ Guy, Simon, and Graham Farmer, "Reinterpreting Sustainable Architecture: The Place for Technology," In *Journal of Architectural Education*, 142.

⁴⁶ Cayuela, Alberto, and Angelique Pilon, "Test Lab for Sustainability," *High Performing Buildings*, Spring 2015, 40. PDF.

⁴⁷ Webber, Michael, "Tapping the Trash," 53.

⁴⁸ The University of British Columbia. Building Systems Manual, https://cirs.ubc.ca/building/building-manual/project-design/.

⁴⁹ Guy, Simon, and Graham Farmer, "Reinterpreting Sustainable Architecture: The Place for

Technology," In *Journal of Architectural Education*, 145.; The University of British Columbia, "Research Portfolio."

⁵⁰ "Is This North America's Greenest Building?," https://thinkprogress.org/is-this-north-americas-greenest-building

b570d55ae126/.; The University of British Columbia, "Research Portfolio."

⁵¹ The University of British Columbia, "Research Portfolio."

⁵² Schultz, "Tour of Hitchcock Center."

⁵³ Schultz, "Tour of Hitchcock Center."

⁵⁴ Schultz, "Tour of Hitchcock Center."

⁵⁵ Slavin, Terry, "An incinerator with a view: Copenhagen waste plant gets ski slope and picnic area,"

https://www.theguardian.com/cities/2016/oct/26/incinerator-copenhagen-waste-plant-bjarke-ingels-ski-slope.

⁵⁶ Abstract: The Art of Design, "Bjarke Ingels: Architecture," Episode 4, season 1.; Slavin, Terry, "An incinerator with a view."

⁵⁷ Slavin, Terry, "An incinerator with a view."

⁵⁸ Abstract: The Art of Design; Slavin, Terry, "An incinerator with a view."

⁵⁹ Perkins + Will. *Site Plan*. Image. https://www.archdaily.com/343442/centre-for-interactive-research-on-sustainability-

perkins-will/51405dc9b3fc4b7556000054-centre-for-interactive-research-on-

sustainability-perkins-will-site-plan.

⁶⁰ Tessler, Martin. Centre for Interactive Research on Sustainability / Perkins + Will. Photo.

https://www.archdaily.com/343442/centre-for-interactive-research-on-sustainability-perkins-

will/51405 cb 2b 3 fc 4b 755600004 b-centre-for-interactive-research-on-sustainability-perkins-will-photo.

⁶¹ The University of British Columbia. *Centre for Interactive Research on Sustainability Exterior*.

Image. The University of British Columbia. http://cirs.conference.sustain.ubc.ca/2011/09/08/centre-for-interactive-research-on-sustainability-cirs/.

⁶² Perkins + Will. *Ground Floor Plan*. Image. https://www.archdaily.com/343442/centre-for-interactive-research-on-sustainability-perkins-will/51405dbfb3fc4b7556000053-centre-for-interactive-research-on-sustainability-perkins-will-ground-floor-plan.

⁶³ Solar Aquatic Lab. Photograph. The University of British Columbia. https://news.ubc.ca/2015/08/31/ubc-expert-calls-for-better-water-recycling-in-b-c/.

⁶⁴ Tessler, Martin. Centre for Interactive Research on Sustainability / Perkins + Will Atrium. Photo.
 https://images.adsttc.com/media/images/5140/5d09/b3fc/4b75/5600/004f/large_jpg/The_atrium_is_an_educati
 onal_space_where_all_of_CIRS's_visible_sustainable_strategies_are_on_display.jpg?1363172612
 ⁶⁵Tessler, Martin. Centre for Interactive Research on Sustainability / Perkins + Will Auditorium. Photo.
 https://images.adsttc.com/media/images/5140/5cfa/b3fc/4b33/b000/0054/large_jpg/The_450seat_auditorium_i
 s daylit from above.jpg?1363172594

⁶⁶ Tessler, Martin. *Centre for Interactive Research on Sustainability / Perkins + Will Green Roof.* Photo.
 https://images.adsttc.com/media/images/5140/5d33/b3fc/4b75/5600/0052/large_jpg/The_living_roof_on_the_r oof_of_the_auditorium_provides_a_courtyard_amenity_for_office_users..jpg?1363172650
 ⁶⁷ Amager Bakke Waste Incinerator. Image. http://www.architectmagazine.com/project-gallery/amager-resource-center-6588.

Bibliography

Abstract: The Art of Design. "Bjarke Ingels: Architecture." Episode 4, season 1. Netflix.

Amager Bakke Waste Incinerator. Image. Architect Magazine. Accessed December 14, 2017.

http://www.architectmagazine.com/project-gallery/amager-resource-center-6588.

Cayuela, Alberto, and Angelique Pilon. "Test Lab for Sustainability." High Performing

Buildings, Spring 2015, 34-43. PDF.

"Centre for Interactive Research on Sustainability." Green Building Brain.

http://greenbuildingbrain.org/buildings/centre_for_interactive_research_on_sustainability

"Centre for Interactive Research on Sustainability / Perkins + Will." ArchDaily. Last modified

March 13, 2013. Accessed December 7, 2017. https://www.archdaily.com/343442/centre-

for-interactive-research-on-sustainability-perkins-will.

"CIRS Virtual Tour." YouVisit. Accessed December 6, 2017.

https://www.youvisit.com/tour/cirs.website/89506.

- Construction Today Magazine. "Centre for Interactive Research on Sustainability." Construction Today. http://www.construction-today.com/90-print/canadian/469-centre-for-interactiveresearch-on-sustainability.
- Guy, Simon, and Graham Farmer. "Reinterpreting Sustainable Architecture: The Place for Technology." In Journal of Architectural Education, 140-48. PDF.

- "Is This North America's Greenest Building?" ThinkProgress. Last modified November 27, 2011. Accessed December 7, 2017. https://thinkprogress.org/is-this-north-americas-greenest-building-b570d55ae126/.
- "LEED Spotlight: UBC's LEED Platinum Centre for Interactive Research on Sustainability." Canada Green Building Council. Accessed December 7, 2017. https://www.cagbc.org/Archives/EN/Leed_Project_Spotlight/November_2013_Centre.as p.
- McDonough, William. "How Cities Could Save Us." *Scientific American*, July 2017, 44-48. PDF.
- Neuman, David. "Design Shaping the 21st Century College Camp." N.d. PDF.
- NGO Committee on Education, comp. "Our Common Future, From One Earth to One World." N.p.: UN Documents, n.d. http://www.un-documents.net/ocf-ov.htm#I.1.
- Perkins + Will. Ground Floor Plan. Image. ArchDaily. March 13, 2013. Accessed December 6, 2017. https://www.archdaily.com/343442/centre-for-interactive-research-onsustainability-perkins-will/51405dbfb3fc4b7556000053-centre-for-interactive-researchon-sustainability-perkins-will-ground-floor-plan.
- Site Plan. Image. ArchDaily. March 13, 2013. Accessed December 8, 2017.
 https://www.archdaily.com/343442/centre-for-interactive-research-on-sustainability-perkins-will/51405dc9b3fc4b7556000054-centre-for-interactive-research-on-sustainability-perkins-will-site-plan.
- Schultz, Jessica. "Tour of Hitchcock Center." Speech, Hitchcock Center, Hampshire College Amherst, MA, September 19, 2017.

- Slavin, Terry. "An incinerator with a view: Copenhagen waste plant gets ski slope and picnic area." The Guardian. Last modified October 26, 2016. https://www.theguardian.com/cities/2016/oct/26/incinerator-copenhagen-waste-plant-bjarke-ingels-ski-slope.
- Solar Aquatic Lab. Photograph. The University of British Columbia. August 31, 2015. Accessed December 8, 2017. https://news.ubc.ca/2015/08/31/ubc-expert-calls-for-better-waterrecycling-in-b-c/.
- Tessler, Martin. Centre for Interactive Research on Sustainability / Perkins + Will. Photo.
 ArchDaily. March 13, 2013. Accessed December 8, 2017.
 https://www.archdaily.com/343442/centre-for-interactive-research-on-sustainability-perkins-will/51405cb2b3fc4b755600004b-centre-for-interactive-research-on-sustainability-perkins-will-photo.
- . Centre for Interactive Research on Sustainability / Perkins + Will Auditorium. Photo. ArchDaily. March 13, 2013. Accessed December 8, 2017. https://images.adsttc.com/media/images/5140/5cfa/b3fc/4b33/b000/0054/large_jpg/The_ 450-seat_auditorium_is_daylit_from_above.jpg?1363172594
 . Centre for Interactive Research on Sustainability / Perkins + Will Atrium. Photo. ArchDaily. March 13, 2013. Accessed December 8, 2017. https://images.adsttc.com/media/images/5140/5d09/b3fc/4b75/5600/004f/large_jpg/The_ atrium_is_an_educational_space_where_all_of_CIRS's_visible_sustainable_strategies_ar

e_on_display.jpg?1363172612

———. *Centre for Interactive Research on Sustainability / Perkins + Will Green Roof.* Photo. ArchDaily. March 13, 2013. Accessed December 14, 2017.

https://images.adsttc.com/media/images/5140/5d33/b3fc/4b75/5600/0052/large_jpg/The_ living_roof_on_the_roof_of_the_auditorium_provides_a_courtyard_amenity_for_office_ users..jpg?1363172650

- "2013 Wood Design Awards Project Fact Sheet Centre for Interactive Research on Sustainability." Wood Works. Last modified 2013. Accessed December 8, 2017. http://wood-works.ca/wp-content/uploads/2013/12/recipients4-GreenBuildingAward.pdf.
- "UBC Centre for Interactive Research on Sustainability." Design Build Network. Accessed December 8, 2017. https://www.designbuild-network.com/projects/ubc-centre-forinteractive-research-on-sustainability/.
- "UBC's Centre for Interactive Research on Sustainability." Video file, 01:45. YouTube. Posted by University of British Columbia, November 2, 2011. Accessed December 8, 2017. https://www.youtube.com/watch?v=dzNZO7WXBw4.
- United States Environmental Protection Agency. "Greenhouse Gas Equivalencies Calculator." United States Environmental Protection Agency. Accessed December 8, 2017. https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator.
- The University of British Columbia. Building Systems Manual. Centre for Interactive Research on Sustainability. Accessed December 8, 2017. https://cirs.ubc.ca/building/buildingmanual/project-design/.
- The University of British Columbia. *Centre for Interactive Research on Sustainability Exterior*. Image. The University of British Columbia. http://cirs.conference.sustain.ubc.ca/2011/09/08/centre-for-interactive-research-on-sustainability-cirs/.

- The University of British Columbia. "Research Portfolio." Centre for Interactive Research on Sustainability. Accessed December 8, 2017. http://cirs.ubc.ca/research/regenerativeneighbourhoods/.
- "University of British Columbia, The Centre for Interactive Research on Sustainability (CIRS)." Perkins + Will. Accessed December 8, 2017. http://perkinswill.com/work/the-centre-forinteractive-research-on-sustainability-cirs.html.

Webber, Michael. "Tapping the Trash." Scientific American, July 2017, 48-53.

PDF.