

ANNUAL REPORT 2019



PICS is hosted and led by the University of Victoria in collaboration with the University of British Columbia, Simon Fraser University and the University of Northern British Columbia.

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Cover photo: NASA Goddard Space Flight Center: A supercomputer model of CO2 levels in the Earth's atmosphere; visualization of data from Jan 26, 2006.

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GAINING MOMENTUM ON CLIMATE ACTION

2019 marked a critical juncture in tackling climate change, with a youth-driven movement demanding action from leaders and banishing deniers to the history books.

Increasing the level of climate solutions ambition, impact and collaborative engagement between researchers and decision-makers, to ensure we deliver what they need, has been a priority for the Pacific Institute for Climate Solutions (PICS).

In 2019 we entered new fields of research, expanded our role as a climate solutions broker at the provincial and national scale in Canada, and grew PICS leadership within our four universities; the University of Victoria, University of British Columbia, Simon Fraser University and the University of Northern British Columbia.

The vision outlined in our 2017-2022 Strategic Plan is now under active implementation, with the launch of six projects in 2019 under our new Theme Partnership and Opportunity Projects programs. Significantly, our first \$1 million Theme partnership, Solid Carbon, also takes PICS into a new field of research endeavour, negative emissions technologies, or NETs.

This ambitious ocean-based project aims to extract carbon dioxide using a direct air capture technology powered by wind, then inject the CO₂ into the subseafloor basalt, where it mineralizes into solid carbonate rock; a permanent climate solution. The team will investigate technical

feasibility and design, as well as the social and legal implications.

We need to pursue and invest in these potential game-changers for combating climate change and for being leaders in the emerging low-carbon economy. Climate scenarios now show that NETs are needed to limit warming to two degrees Celsius. However, NETs are not an excuse to slow progress on urgently needed climate change mitigation and adaptation solutions.

"In 2019 we entered new fields of research, expanded our role as a climate solutions broker at the provincial and national scale in Canada, and grew PICS leadership within our four universities."

Our five new Opportunity Projects speak to that imperative. Climate adaptation is the driving force behind plans to better utilize First Nations traditional knowledge for managing Canada's undersea kelp forests, as well preparing to support communities displaced by climate impacts. We are developing tools to support climate-adapted conservation planning, and to design energy efficient and climate resilient residential buildings. Climate mitigation is a key driver behind another project to transport off-the-grid urban waste heat into district energy networks.

Impactful research results are also being delivered by our ongoing projects. I invite you to visit the Advancing Solutions section of this

report to find out how national and provincial energy regulators, electricity providers, trusts, government departments, and communities are using PICS research discoveries in 2019.

Also, visit our new website at PICSCanada.ca, which is part of our strategic plan's commitment to elevate outreach and engagement. The new interface offers easy navigation to our research, events, and funding/ partnership opportunities, as well as a direct connection to our growing PICS community.

I am proud to say that the new 'PICS Way' is well underway, with collaborative engagement now underpinning everything we do, from our events to our research. We are engaging more with students and faculty, as we bring onboard tomorrow's leaders in climate solutions. PICS is also gaining national and international prominence as part of the new Canadian Institute for Climate Choices, and through the increasingly multi-national composition of our research teams.

As we look to 2020 with new major projects pending and innovative ideas ripe for development, I want to thank the tremendous support of our PICS community and PICS staff, for helping advance the climate solutions that society, especially youth, now demand.

Dr. Sybil Seitzinger
Executive Director





THE 'PICS WAY'

2019 represents the first full year of implementing PICS' new strategic collaborative partnership approach, which is changing the way we plan, design and deliver our research and events.

The 'PICS Way' means the co-design, co-development and co-delivery of climate solutions by the three partners within all PICS projects: the Solution Seeker, the Research Partner and the PICS Partner.



NEW IN 2019

COLLABORATIVE RESEARCH AND ENGAGEMENT

Our collaborative research and engagement model unites researchers with solution seekers in government, industry, NGOs and communities, to inspire and drive research excellence through a solutions-focused lens.

Our mission is clear: delivering impactful climate solutions that support our goal of achieving net-negative emissions with adapted and resilient ecosystems.

It is vital that researchers and the people who will use their research results (solution seekers) are closely connected to ensure that projects can evolve alongside shifts in technology, policy, need, and environmental change.

Researchers-In-Residence

Enter into this relationship the PICS Researcher-in-Residence, a new staff role launched within the institute in 2019 that offers an exceptional opportunity to be at the nexus of climate solutions research and engagement.

This PICS Partner position, created under our Research Engagement Program, bridges the traditional separation between research and practice by increasing knowledge sharing between experts in relevant fields as well as developing new initiatives and driving forward innovative climate solutions. PICS' first Researcher-in-Residence started in June 2019.

PICS' first Researcher-in-Residence Built Environment, Hannah Teicher explains why this unique role offers an exceptional opportunity to advance climate solutions:

Having been immersed in two worlds—as a former practicing architect and having recently completed a PhD in urban and regional planning at MIT—I wanted to develop climate solutions for urban areas that were not only academically sound but also used. Joining PICS in 2019 as the first Researcher-in-Residence offered me a unique opportunity to utilize my knowledge of architectural practice and complex adaptation planning.

"The new staff role Researcher-in-Residence offers an exceptional opportunity to be at the nexus of climate solutions research and engagement."

I have made connections between our research community, government and industry within existing PICS projects tackling energy efficiency in the built environment and integrating adaptation and mitigation in affordable housing. I am now synthesizing promising practices from international leaders to inform the upcoming BC government's adaptation strategy.



Hannah Teicher,
PICS' first Researcher-in-Residence

Another priority is accelerating the momentum on tackling embodied emissions, a new frontier of climate action. Addressing embodied carbon offers a huge opportunity to reduce emissions in all parts of the supply chain, well beyond the typical focus on urban energy use for heating, cooling and operations, and beyond jurisdictional borders. I am developing a resource for practitioners and public sector organizations to inform their current practices and also synthesizing research at the intersection of embodied emissions and smart cities, framing critical questions for a next generation of practice.



THEME PARTNERSHIP PROGRAM

The PICS Theme Partnership Program supports research projects valued up to \$1 million into particularly complex—and critically important—climate mitigation and adaptation challenges.

In 2019 we launched our first Theme project and entered a new research field of negative emissions technologies.



SOLID CARBON: NEGATIVE EMISSIONS TECHNOLOGY

Turning the greenhouse gas carbon dioxide into rock by injecting it beneath the Earth's ocean floor is the goal of PICS' first \$1M Theme Partnership project called "Solid Carbon" launched in September 2019.

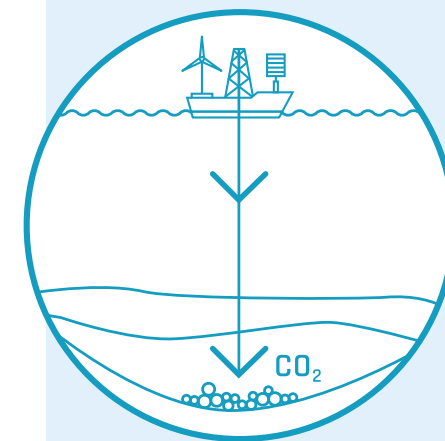
The sheer ambition and world-wide scale of this potential negative emissions technology captured the public imagination, with radio, print and television networks including Global Television news networks and CBC covering the story.

The four-year international project brings together scientists, engineers and social scientists from the University of Victoria; Ocean Networks Canada (ONC), a UVic initiative; University of British Columbia; University of Calgary; University of California; Columbia University; the University of Washington; and GEOMAR Helmholtz Centre for Ocean Research in Germany. Other project partners include K&M Technology Group, and Carbon Engineering in Squamish.

The team aims to combine state-of-the-art technologies in renewable energy production, carbon capture, offshore drilling and carbon mineralization in a completely new way to deliver safe and reliable carbon dioxide (CO₂) removal.

Kate Moran, the project principal investigator, UVic professor and ONC President and CEO, says the vision is to extract CO₂ from the atmosphere using a direct air capture technology (developed by Carbon Engineering). Then, using deep ocean technology powered by wind energy at sea, inject the CO₂ into the subseafloor basalt, where it will mineralize and remain permanently as rock.

HOW IT WORKS



Direct air capture (powered by renewable energy) at sea, injecting CO₂ into basalt where it becomes rock.

More than 90 per cent of basalt resides in the ocean where it is widely distributed, making the technology ideal for world-wide use. One of the project's initial focus areas is modelling and laboratory experiments to demonstrate sequestration of CO₂ into ocean basalts that lie beneath ONC's Cascadia Basin site off the west coast of British Columbia.

If this team can advance the technology to a commercially viable stage by mid-century, it could be a major tool to combat climate change. In preparation for that, the project will also examine social, regulatory, and investor acceptance, including gaps in current law.



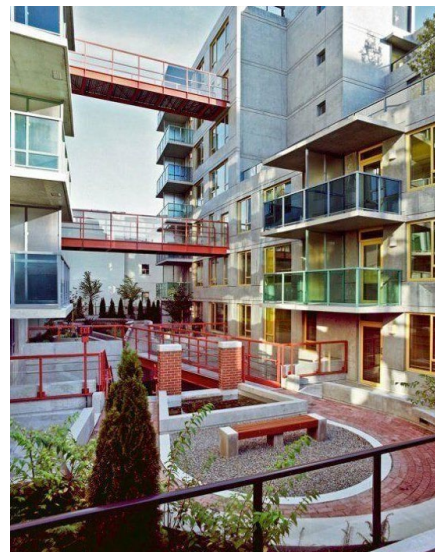
LEFT: Key people behind the Solid Carbon vision: UVic engineering professor Curran Crawford, the president and CEO of ONC, Kate Moran, and Sybil Seitzinger, the executive director of PICS (plus Lucy the dog). **RIGHT:** A core of basalt rock showing carbonate mineral deposits, Iceland. *Credit: PICS*



OPPORTUNITY PROJECTS PROGRAM

How does a new climate solutions idea, never before tested, get off the ground? The Opportunity Projects Program encourages research teams to take bold, but calculated, risks in pursuit of high-impact climate mitigation or adaptation solutions within the relatively near-term.

In 2019 we launched our first five OPPS projects.



Credit: Architecture Vancouver Facebook

ADAPTIVE MITIGATION: ASSESSING CLIMATE CHANGE SOLUTIONS IN URBAN MULTIFAMILY BUILDINGS

Extreme heat, drought, wildfires, poor air quality, flooding and power outages – these hazards are more likely to occur in British Columbia because of climate change, and the design of our future residences should prepare for that, plus promote energy efficiency and greenhouse gas (GHG) reductions. But designers need tools for that.

In partnership with BC Housing, this UBC-led project aims to deliver an integrated building adaptation and mitigation assessment (IBAMA) framework and tool to help planners identify solutions for incorporating both factors in multifamily residential building design, construction and operations. Taking this 'big picture' approach reduces the risk of unintended consequences from considering mitigation and adaptation separately, optimizes benefits and reduces project costs.

Tasks completed in 2019 include data collection, expert interviews and analysis of leading climate building policies and practices in BC and New York. Creative solutions for integrating adaptation and GHG reductions

"The long-term goal is improving future building codes, standards, and construction best practices in BC and abroad."

using BC Housing project case studies have also been gathered from a 40+ industry experts' workshop.

Initial results indicate the need for an IBAMA framework that is process-oriented, serves as a communication tool, considers both social and technical factors, includes multiple hazards and scales, and considers the full lifespan of a building. The long-term goal is improving future building codes, standards, and construction best practices in BC and abroad.



Ilana Judah, lead researcher, architect and M.Sc. Student at UBC, who is developing an adaptive mitigation tool for multifamily residential buildings.



INTEGRATING CITY INDUSTRIAL WASTE-HEAT INTO A DISTRICT ENERGY NETWORK

Work is well underway to develop a thermal storage “missing link” that will enable transmission of waste heat from off-the-grid urban and industrial sources into district energy networks.

In collaboration with the City of Surrey and Canmet ENERGY, this Simon Fraser University (SFU) led project aims to develop a pre-market modular, thermochemical-based mobile thermal energy storage (M-TES) prototype. The proposed system will capture and transport waste heat from remote sources into urban district energy systems.

Since reviewing different energy storage options, researchers are now investigating M-TES integration into Surrey’s district energy system. This includes determining the industrial waste heat available within a 15km radius of the city and designing a

thermochemical storage module for an M-TES heat exchange system. Other advances include creating a GHG emission reduction calculator to evaluate the climate impact of different transportation modes, distances, schedules and energy storage densities.

The heat stored in the M-TES can be used for peak shaving and to offset the consumption of non-renewable sources. Potential benefits include the integration of bioenergy into Surrey’s energy stock, a reduced reliance on natural gas for peak loads, and reduced carbon emissions.



ABOVE: The project team outside the City of Surrey’s West Village Energy Centre
RIGHT: Heat exchangers and potential absorbents with high energy density, under investigation by the project’s mobile thermal energy team.





UNDERSEA FORESTS

Climate change is threatening Canada’s east and west coast kelp forests which are vital to ocean ecosystems and to coastal communities reliant on kelp for commercial, food, social, and ceremonial purposes.

In 2015 BC central coast First Nations communities observed expansive outbreaks of an epiphytic marine invertebrate called bryozoan in correlation with extreme ocean temperature anomalies (“warm blob”) in the northeast Pacific Ocean. Giant kelps were heavily encrusted by the bryozoan, causing them to sink to the seafloor and disintegrate.

This project partnership between SFU and the Central Coast Indigenous Resource Alliance that encompasses all four First Nations of BC’s central coast (Heiltsuk Nation, Kitasoo/ Xai’ xais Nation, Nuxalk Nation and the Wuikinuxv Nation), will determine whether adaptive management of traditional community-based kelp harvest and herring spawn-on-kelp fisheries can minimize the negative impact of such outbreaks.

"Giant kelps were heavily encrusted by the bryozoan, causing them to sink to the seafloor and disintegrate."

The project team aims to take a whole ecosystem-based approach to finding adaptation solutions including utilizing traditional knowledge on the historical distribution and abundance of kelp and bryozoan on the Central Coast. Field work begins in 2020.



FAR LEFT: BC’s Central Coast kelp forests.

Credit: Anne Salomon

TOP: Jordan Wilson collecting herring roe.

Credit: Ian McAllister

MIDDLE: Kickoff workshop for the Climate Change Solutions for Canada’s Undersea Forests Project. *Credit: Mike Vegh (Heiltsuk Nation)*

ABOVE: BC Kelp Forest. *Credit: Lynn Lee*



UVIC | PROJECT DURATION: 9 MONTHS

CLIMATE CHANGE DISPLACEMENT: MAPPING THE BC CONTEXT

This project aims to lay the groundwork for helping British Columbia prepare for the movement of people to and within the province due to climate change displacement.

Despite heightened awareness about the issue—due, in part, to media coverage of more frequent climate-related extreme weather events, sea level rise and ice melt, for example—BC, like many jurisdictions, has yet to mobilize stakeholders in preparation.

This short-term scoping project marks the beginning of a partnership between PICS, the

Centre for Global Studies at the University of Victoria, and the Climate Migrants and Refugees Project (an NGO in Vancouver). Collectively they will establish a network of relevant stakeholders from governments and society to identify knowledge gaps, and develop a research agenda on solutions to the climate displacement challenge.



UNBC / UBC | PROJECT DURATION: THREE YEARS

CLIMATE ADAPTIVE PLANNING FOR BC'S PROTECTED AREAS

There is currently no planning tool available that considers future climate change when establishing protected areas in British Columbia and projecting impacts on natural systems.

This project aims to meet that need by developing the first online, open-access and user-friendly tool to support climate-adapted conservation planning across BC's natural and

protected areas. This tool will be flexible for diverse user groups, preloaded with data, and updatable for future advances in BC climate change knowledge.

This project is a partnership involving the University of Northern British Columbia, the University of British Columbia, The Nature Trust, Canadian Parks and Wilderness Society and the BC Parks Foundation.





ADVANCING SOLUTIONS

Discoveries that advance and inform climate change mitigation and adaptation for British Columbia, Canada and potentially the world.

Some research highlights from 2019 include the following.



ELECTRIFYING ALL BC TRANSPORTATION

We know we need to clean up transportation, which contributes more than a third of British Columbia’s sectoral greenhouse gas (GHG) emissions. But how much additional clean energy would BC need to electrify every car, truck and bus, what it would cost us, and what is the climate benefit?

Enter researchers from the PICS 2060 Project at the University of Victoria who calculated that a 100% electric fleet on BC roads by 2055 could require electricity generation capacity to more than double to meet the forecast total energy demand.

Breaking down the numbers of this scenario, BC will need to increase its electrical production capacity from a 2015 baseline of 15.6 gigawatts (GW) to 23 GW to meet forecast 2055 economic and population growth alone. Factor in all-electric road transportation, and up to an additional 60 per cent capacity is needed. This would more than double BC’s electricity generation capacity to 37 GW.

Surprisingly, the cost of generating the extra electricity could be relatively cheap.

The team found that 60 per cent capacity boost for transport would raise the average unit cost of electricity by only nine per cent due to low cost energy options. Furthermore, the costs would only rise by five per cent if at least half of drivers charged their vehicles at off-peak times. Why? Because spreading the demand means less need for capacity build-out.

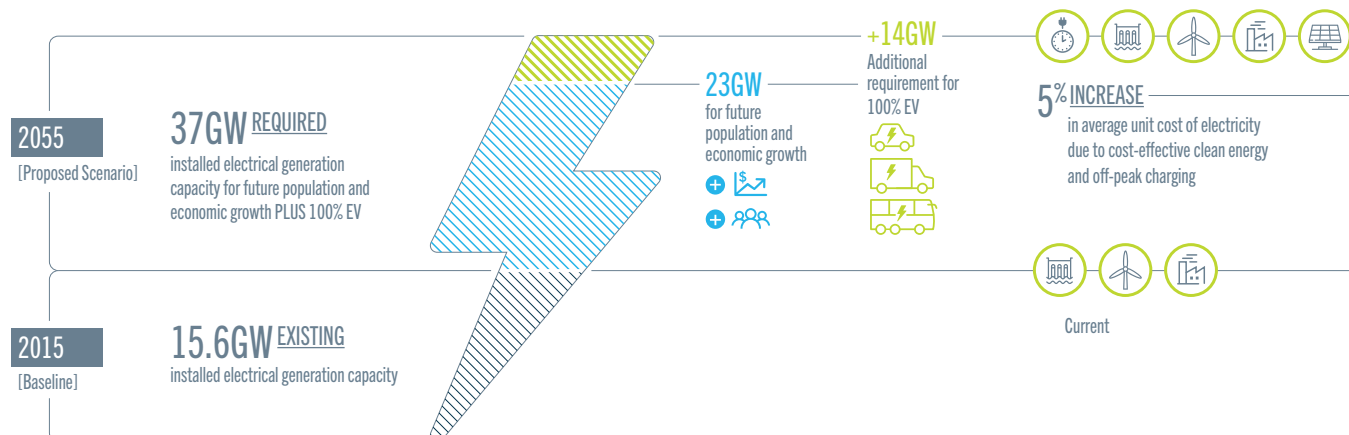
Co-author Curran Crawford, a professor with UVic’s Institute for Integrated Energy Systems says low cost options such as wind and solar power would keep a lid on energy prices.

As for the climate benefit, a clean energy road fleet would reduce total emissions from the combined transportation and electricity sectors by 38 per cent (or 260 MtCO₂) between 2015 and 2055, relative to business as usual.

The finding attracted media coverage from radio, print and television networks including Global TV News, Chek News and Postmedia publications. The research team was also invited to present in January 2020 to the Canadian Electricity Association, a nationwide energy body.

Keller, V., English, J., Fernandez, J., Wade, C., Fowler, M., Scholtysik, S., Palmer-Wilson K., Donald, J., Robertson, B., Wild, P., Crawford, C., & Rowe, A. (2019). *Electrification of road transportation with utility controlled charging: A case study for British Columbia with a 93% renewable electricity target.* Applied Energy, 253, 113536

100% ELECTRIC TRANSPORT IN BC BY 2055





HYDROGEN HIGHWAY: A ROADMAP ACROSS BC

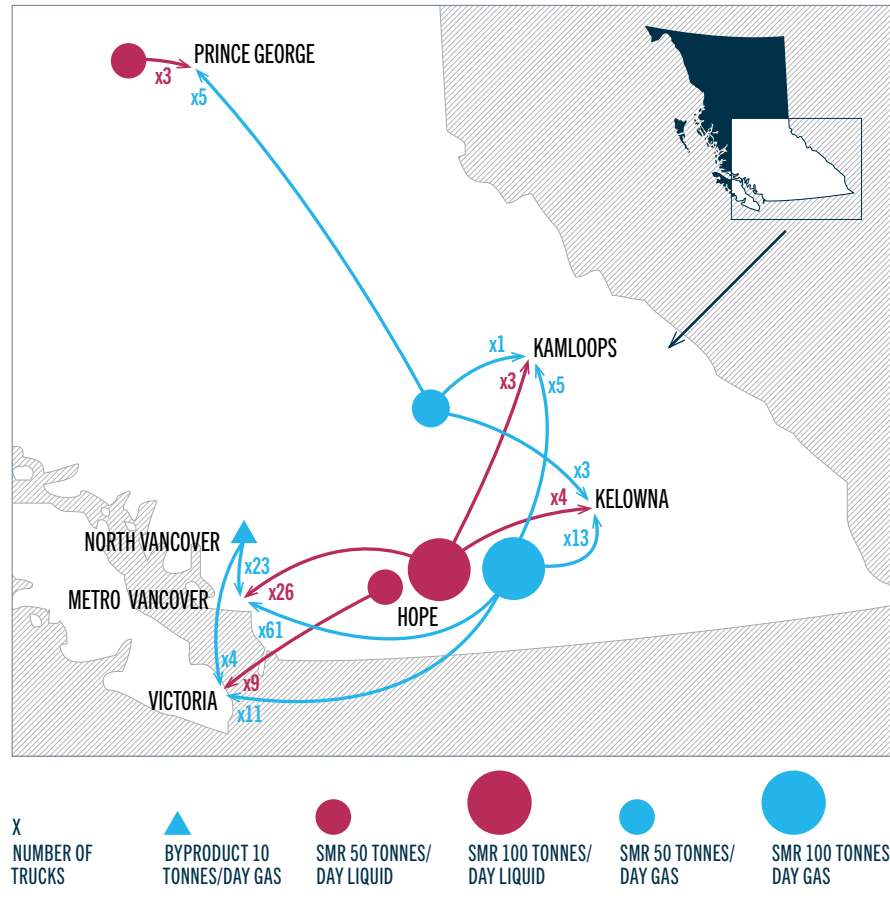
PICS-supported researchers at the University of British Columbia have developed a hydrogen supply chain model to enable the adoption of zero-emission, hydrogen-powered vehicles—transforming them from a novelty into everyday transportation in just 30 years.

In their 2019 study, UBC researchers recommend a refuelling infrastructure extending from Prince George to Kamloops and Vancouver, and to Victoria in the west. Production plants would capture by-product hydrogen from chemical plants or produce it from water electrolysis and steam methane reforming.

A network of refuelling stations would need to be established in major urban centres to help promote mass adoption. Currently there is one public retail hydrogen station in Vancouver (Canada’s first), with six more slated for that city and Victoria by late 2020.

"We see a future where hydrogen can be economically competitive with gasoline, while significantly reducing GHGs."

"Hydrogen-powered vehicles are a strong alternative to battery electric vehicles, which don't always comply with fast-refuelling, long-distance travel or cold weather requirements,"



says lead author Hoda Talebian, a doctoral student in mechanical engineering at UBC.

The researchers, all affiliated with PICS Transportation Futures for BC project and UBC’s Clean Energy Research Centre (CERC), also identified the potential positive effects of policy tools like BC’s carbon tax and the low carbon fuel standard in helping support hydrogen demand. Significantly, they see a future where hydrogen can be economically

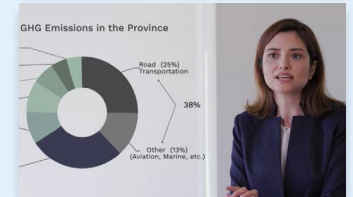
competitive with gasoline, while significantly reducing greenhouse gas emissions.

The BC government’s CleanBC plan includes a zero-emission vehicle mandate by 2040.

Talebian, H., Herrera, O. E., & Mérida, W. (2019). Spatial and temporal optimization of hydrogen fuel supply chain for light duty passenger vehicles in British Columbia. International Journal of Hydrogen Energy, 44(47), 25939–25956.

ELECTRIFICATION OF ROAD FREIGHT TRANSPORT VIDEO

Produced by the Transportation Futures for BC project, this video hosted on the PICS website explores clean energy transportation options for the province.



Screenshots from the video including UBC PHD Candidate in mechanical engineering Hoda Talebian and Senior Program Manager Omar Herrera.



RINGS REVEAL SPEEDY TREES

The growth rate of Canada’s iconic black spruce trees has almost doubled over the 20th century and environmental change driven by human activities is the cause.

This is a key finding of an investigation into the growth of black spruce which are found coast-to-coast in boreal forests from British Columbia to Newfoundland and Labrador.

Researchers with the PICS Forest Carbon Management Project analyzed the rings of dominant black spruce trees that were cored at 248 plots across Canada. The tree cores had been collected during the early 2000’s at field plots within the Boreal Cordillera, Boreal Plain and Boreal Shield ecozones, as part of Canada’s National Forest Inventory.

When comparing rates of tree development with calendar years, they found a stunning 154—321 percent increase in the growth rate of dominant individual trees between 1901 and 2001.

But there is a twist, as explained by Robbie Hember, lead author of the article, PICS postdoctoral fellow and now a forest carbon modeller with the BC government.

“Part of the trend was likely due to the decision to core dominant trees only, as well as limitations in the ability to measure past tree growth,” he says. So, the researchers ran a computer simulation model that predicted how non-dominant trees grow to gain insight into the growth rates of entire forest stands.

After accounting for various negative feedback mechanisms (such as smaller trees receiving less sunlight than their larger neighbours), they calculated that the average growth rate of black spruce trees likely increased by somewhere between 45 and 80% between 1901 and 2001.

“When comparing rates of tree development with calendar years, they found a stunning 154—321 percent increase in the growth rate of dominant individual trees between 1901 and 2001.”

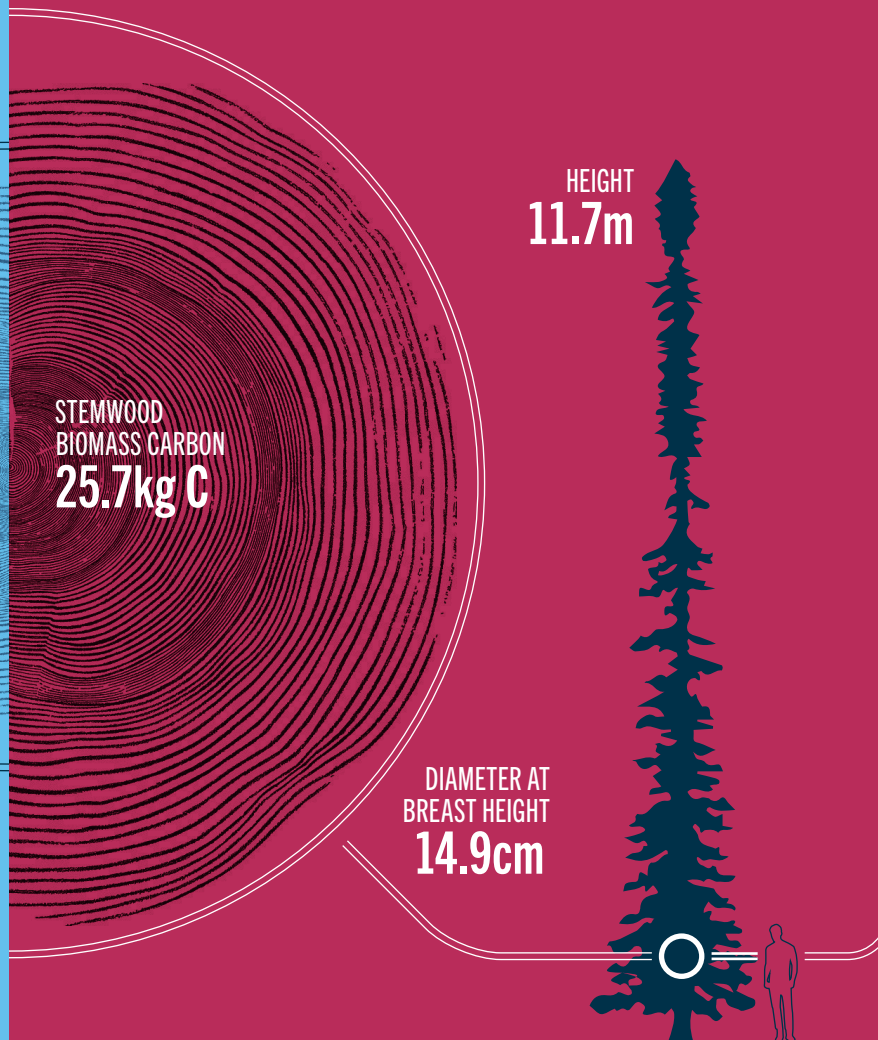
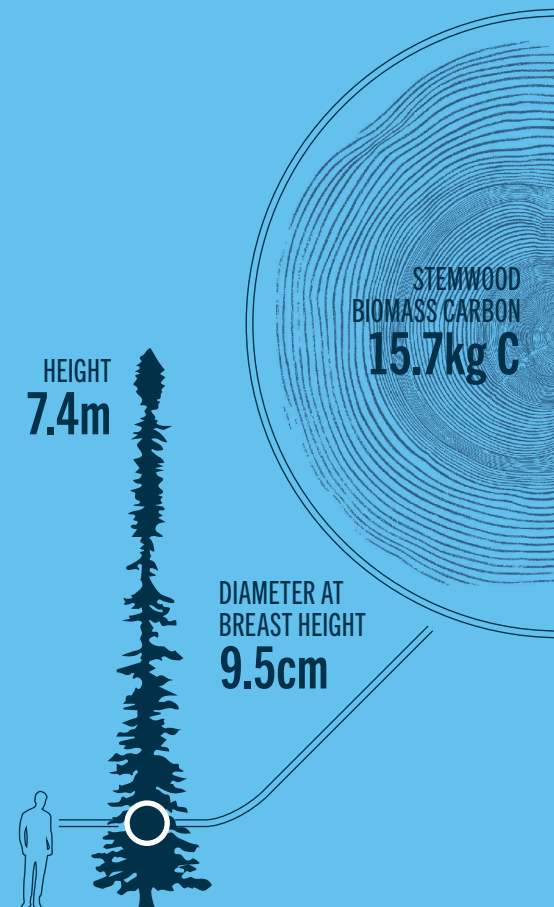
This result provides an example of where humans are enhancing tree growth by increasing reactive nitrogen, atmospheric carbon dioxide and temperature levels, through activities including fertilizer application, fossil fuel combustion, and livestock production. Understanding why, where and when environmental changes impact BC’s forests positively or negatively is one objective of the PICS Forest Carbon Management Project.

Hember, R.A., Kurz, W.A., and Girardin, M.P. (2019). *Tree-ring reconstructions of stemwood biomass indicate increases in the growth rate of black spruce trees across boreal forests of Canada*. JGR: Biogeosciences, vol. 124, pages 2460-2480.

**CHANGE IN BLACK SPRUCE GROWTH:
COMPARING THE SIZE OF 95-YEAR-OLD
BLACK SPRUCE THEN AND NOW**

**GROWING
CONDITIONS IN
1901**

**GROWING
CONDITIONS IN
2000**



CAUSAL FACTORS



**INCREASES IN ATMOSPHERIC
NITROGEN, INCLUDING:**

- Ammonia (NH₃) from use of synthetic fertilizers for field crops and livestock
- Nitrogen oxides (NO_x) from burning of fossil fuels.



**INCREASES IN ATMOSPHERIC
CARBON DIOXIDE**

(280 to ~400 ppm) which, on average, increases tree growth



INCREASES IN GLOBAL WARMING

(~ 1.0 deg C) which, on average, tends to increase tree growth



ON THINNING ICE

A multi-year project to measure climate change impacts on British Columbia's Selkirk, Purcell, and Cariboo mountains is providing valuable data and forecast models on streamflow levels for regulators and stakeholders dealing with those consequences.

Ben Pelto, PICS Fellow and UNBC doctoral student in natural resources and environmental studies, heads to the mountains twice a year to dig snow pits, scrutinize ice cores, and drag around a ground-penetrating radar. He's measuring accumulation and snow density to identify the degree to which glaciers contribute to seasonal streamflows.

He and his team also take to the skies in a small plane equipped with a light detection and ranging, or LIDAR, laser instrument, which fires rapid pulses down to the ice about 6,000 feet below. The instrument can precisely measure changes in the height of the ice above the bedrock.

"From the air... we end up measuring 100 per season, including those that are too dangerous, steep, or small," Pelto explains.

There is no doubt that BC's iconic glaciers are shrinking. The province's annual mean temperature has risen 1.9 degrees Celsius since 1948, while winters have warmed by 3.7 degrees Celsius. And a wide range of solution seekers need precise streamflow-model data.

For example, the Columbia Basin Trust wants to know what freshwater resources might look like in the coming decades, to better target its investments to protect economically,



culturally, and ecologically important species, such as salmon.

Then there's BC Hydro. Factoring in seasonal glacier melt along with changing precipitation patterns due to climate change is part of the crown corporation's long-term planning that affects its 1.8 million customers.

Another beneficiary is Pacific Climate Impacts Consortium which is feeding Pelto's data into its hydrologic model, improving its reliability. Governments and stakeholders use the model to plan the impacts of hotter, drier summers and wetter and warmer winters on BC's freshwater resources.

Pelto has been working with the Columbia Basin Trust, BC Hydro, Environment and Climate Change Canada and others to compile a public report on the state of the cryosphere in the Canadian Columbia River Basin, to be published in 2020.

Pelto, B. M., Menounos, B., & Marshall, S. J. (2019). *Multi-year evaluation of airborne geodetic surveys to estimate seasonal mass balance, Columbia and Rocky Mountains, Canada*. *The Cryosphere*, 13, 1709–1727.



WATER SECURITY AMID NATURAL GAS DEVELOPMENT

PICS research is helping policymakers develop tools to assess risks and prevent potential contamination of Northeastern BC water systems due to oil and gas development.

Industrial development can impact water quality due to wastewater spills and leakage along pipeline and trucking corridors. It can also affect the quantity of water supply through consumption. Hydraulic fracturing and oil and gas production generate wastewater often containing chemicals and high concentrations of salts, metals, and metalloids, which can pose a threat to drinking water supplies and healthy aquatic ecosystems.

Identifying the geologic sites most vulnerable to water quality and quantity deterioration from shale gas operations was a missing piece of the puzzle taken up by the PICS Natural Gas Development and Maximising Net Social Benefits project.

"Identifying the geologic sites most vulnerable to water quality and quantity deterioration from shale gas operations was a missing piece of the puzzle."

Under the supervision of SFU earth sciences professor Diana Allen, PICS postdoctoral fellow Shannon Holding and Zachery McKoen, an undergraduate summer research assistant, developed a new approach for mapping water security vulnerability that shows the spatial distribution of specific hazard threats alongside the susceptibility of water systems to those threats across the Northeast BC

Peace Region. The resulting hazard-specific water vulnerability maps are now being used by industry regulators.

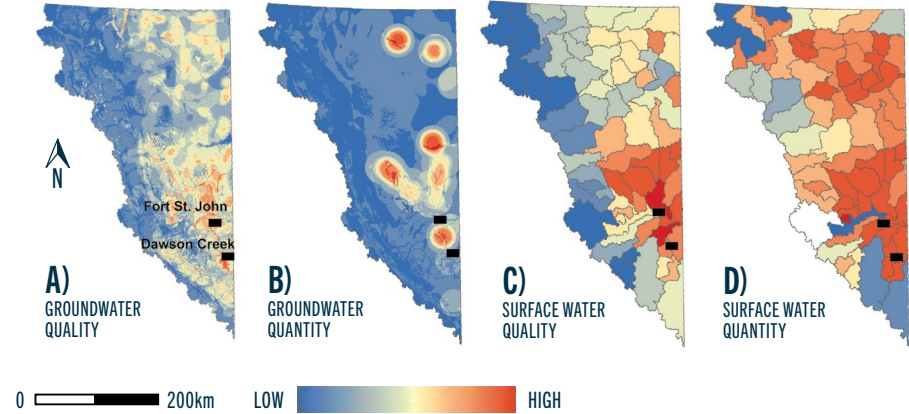
In a 2019 statement the BC Oil and Gas Commission said it is using the data files generated (from this study) to support the development of a map-based groundwater investigation tool. This tool will assist with the development of policies, procedures and guidance documents that will determine the requirements for groundwater investigations on abandoned oil and gas sites to assess groundwater quality and protect groundwater resources.

Dr. Allen says their approach for mapping water security vulnerability—using the hazard threat and susceptibility indicators—could be used to assess other shale gas areas outside BC.

Holding, S., Mc Koen, Z., & Allen, D. M. (2018). *Groundwater and Surface Water Quality and Quantity Vulnerability Mapping in Northeast British Columbia*. Technical Report submitted to BC Oil and Gas Commission.

Holding, S., & Allen, D. M. (2016). *Shallow Groundwater Intrinsic Vulnerability Mapping in Northeast British Columbia* (PICS Briefing Note 2016 – 45).

Allen, D. M., Holding, S., & McKoen, Z. (2018). *Hazard-specific Vulnerability Mapping for Water Security in a Shale Gas Context*. The Water-Energy-Food Nexus. Global Environmental Studies. (pp. 33 - 43).



Vulnerability Northeast BC Peace Region: (A) Groundwater Quality, (B) Groundwater Quantity, (C) Surface Water Quality, and (D) Surface Water Quantity.



Field work by SFU students of Professor Diana Allen



CLIMATE LEADERSHIP ACROSS PICS FOUR UNIVERSITIES

PICS is building a climate solutions-focused community at its four BC universities through initiatives that span the executive, faculty and students, the leaders of tomorrow.

In support of that, our Student Engagement Program aims to enrich students' experience as members of the PICS community. We offer career connections, mentorship, and support to help students better communicate, collaborate on and incubate climate solutions. Below is a snapshot of new and expanding on-campus initiatives during 2019.



UVIC | NEW IN 2019

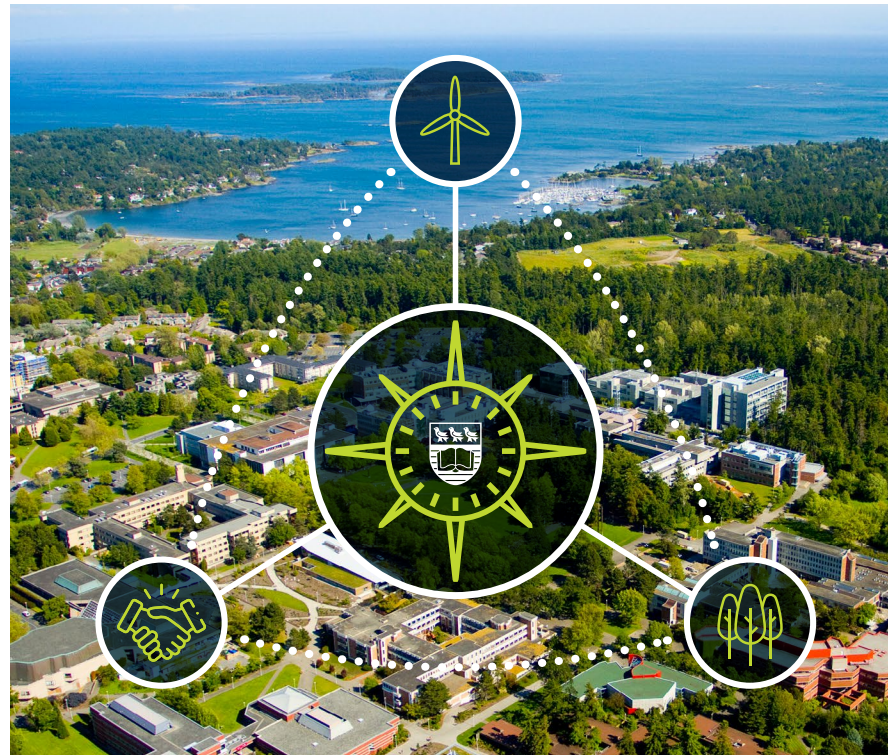
CLIMATE NAVIGATOR

The Climate Solutions Navigator is now live at the University of Victoria thanks to a new partnership between PICS at UVic and the Office of the Vice-President of Research.

This new initiative, which is part of the new PICS University of Victoria Program, has the dual aims of responding to the UVic Strategic Framework and the IPCC Special Report on 1.5 degrees of warming. By actively connecting the university community to climate solutions opportunities and facilitating new research partnerships, the Navigator is helping UVic to

promote sustainable futures in all that it does and move towards a more integrated approach to climate and sustainability action.

The Navigator is guided by a working group—co-chaired by PICS Executive Director Sybil Seitzinger and Associate Vice-President Research Operations Rachael Scarth—that includes UVic deans' representatives and directors. PICS UVic Program Manager Kristy Facer and Tara Todesco (UVic Manager Strategic Initiatives) act as Vice-Chairs, with support from intern Raul Mendoza.



The Climate Solutions Navigator



UVIC

UVIC STUDENT ENGAGEMENT

What should future UVic events and student-focussed programs on climate solutions and sustainability look like? Paige Bennett, PICS' new Student Connections Coordinator, set out to find the answers through a campus-wide student survey in fall 2019, conducted in collaboration with the University of Victoria Sustainability Project. More than 400 students from every faculty responded. PICS at UVic is using that feedback to inform future events and engage more students on climate solutions.



UBC

UBC HUB

PICS at UBC continues to support activities by the student-driven UBC Climate Hub on campus and in the community. The Hub aims to connect and empower university and community stakeholders to take bold climate action for a just future. During 2019 PICS sponsored a successful Climate Solutions Showcase event and offered ongoing mentorship and guidance around the Hub's Youth Climate Ambassadors Project and UBC's climate emergency declaration.



TOP: PICS Intern, Bradley Elliott working with Betsy Agar in Pembina's affordable housing renewable project.

ABOVE: PICS intern Kate O'Neill assessing water quality and identifying cool water inputs as part of a project by the Tsolum River Restoration Society to create a restoration and climate adaptation plan for the river.

INTERNSHIP PROGRAM

Climate adaptation planning at a city level and, separately, for native Caribou populations, supporting an Indian band to achieve clean energy self-sufficiency, and upgrading social housing units into low carbon homes – just a few examples of the important work being undertaken by PICS interns in 2019.

"The City of Kelowna greatly appreciates PICS funding support for Sydney Rankmore's intern position. Through extensive research and collaboration with other city departments and external stakeholders, she was able to draft climate adaptation objectives and policies for our Official Community Plan update."

TRACY GUIDI,
SUSTAINABILITY COORDINATOR AT THE
CITY OF KELOWNA

Our Internship Program supports the hiring of PICS university students at the workplaces of BC governments, NGOs, industry and communities. Students gain vital experience and exposure in a competitive growth job market while helping our solution seeker partners advance climate change solutions.

Eleven internships were awarded in the 2019 call. The successful recipients were; Pembina Institute, BC Government and the Parkland Fuel Corporation, City of Kelowna, Compass Resource Management, District of Summerland, Kanaka Bar Indian Band, Prince George Chamber of Commerce, Tsolum River Restoration Society, Climate Action Secretariat, Community Energy Association, and Renewable Cities.

To date, PICS has funded 118 internship positions worth more than \$1.2 Million.



STUDENT FORUM

Our annual Student Forum in Vancouver brings together the network of PICS scholars across British Columbia: graduate students, postdoctoral fellows and student interns keen to share their climate solutions research, exchange ideas and learn new skills.

New on the agenda for the 2019 forum was a skill development workshop on visual analytics, presentations from PICS alumni on the transition from researcher to solutions implementer, and a student-led discussion on how to engage and mobilize students on climate action. Our current PICS scholars presented their latest research and attended our public evening panel discussion on Tackling Embodied Emissions through Local Climate Action. The forum is led by PICS at SFU.



Some of the PICS-supported scholars attending the annual PICS Student Forum in Vancouver, 2019.



PICS EVENTS IN 2019

PICS supports climate solution-focused events of all kinds, from seminars and workshops to conference sessions and keynote speakers. Our events build knowledge and networks, develop skills, grow capacity, and inspire innovation.

PICS events are primarily located in BC, but are often live webcast and archived online to boost accessibility. Here is a snapshot from the 30-plus events PICS led or co-hosted in 2019, that in total attracted more than 4,000 people.



PANEL DISCUSSION



YOU, ME AND THE IPCC

Students and early-career researchers took the opportunity to directly engage with 17 lead authors from the Intergovernmental Panel on Climate Change (IPCC) current Working Group I, at a “sold-out” free event hosted by PICS on January 9, 2019. More than 160 people registered to attend “You, Me and the IPCC” with another 68 joining online.

The event, introduced by PICS Executive Director Sybil Seitzinger, kicked off with a panel discussion by IPCC Working Group I lead authors Greg Flato from Canada, Krishna AchutaRao from India, Maisa Rojas from Chile, Trude Storelvmo from Norway, William (Bill) Collins from the United States, Veronika Eyring from Germany, and Panmoa Zhai from China.

This was followed by a world café style dialogue, where participants and authors discussed the realities and challenges of producing the world’s biggest scientific analysis of climate change. Less expected perhaps, was hearing authors’ personal stories of the friendships and community resulting from their voluntary work for the IPCC.

The additional IPCC lead authors engaged in the discussion were José Manuel Gutiérrez, Paco Doblas-Reyes, Valérie Masson-Delmotte, Helene Hewitt, Peter Thorne, Jochem Marotzke, Baylor Fox-Kemper, Sonia Seneviratne, Anna Pirani, and Robert Vautard.



PANEL DISCUSSION

CLIMATE-SMART FINANCE

Financial experts came together to discuss the critical role the finance sector can and must play to support the transition to a low-carbon economy, at an event co-hosted by PICS and the Centre for Social and Sustainable Innovation at UVic’s Peter B. Gustavson School of Business on August 29, 2019.

The panelists discussed the recommendations of the Expert Panel on Sustainable Finance and discussed ways of advancing climate smart initiatives, policies and practices in the financial industry in Canada. Questions about the opportunities, gaps and challenges for investors, businesses, financial institutions and markets in the face of global climate change dominated the audience discussion.

The “Climate-Smart Finance: Financial Sector Levels for Advancing a Low-Carbon Economy” event seeded a new partnership between the hosts who are continuing to deepen understanding and identify opportunities to address climate risk through finance. Stay tuned for more finance-related events in 2020.



FROM LEFT: PICS UVic Program Manager Kristy Faccor; Jennifer Coulson, Vice President ESG at BCI; Andrea Moffett, Vice President Ivey Foundation; Cary Krosinsky, co-founder of Carbon Tracker & Real Impact Tracker, Yale University; and Jessica Strauss, Principal Economist Financial Markets, Bank of Canada.

On the screen, Andy Chisholm, Board Director Royal Bank of Canada.



BEYOND CLIMATE IMPACTS ... TO INSPIRING SOLUTIONS

The University of Victoria's Farquhar Auditorium was nearly packed to capacity with 996 people registered for the "Beyond Climate Impacts...to Inspiring Solutions" public movie screening and panel discussion on March 9, 2019.

Ian Mauro's latest film, Beyond Climate, takes viewers on a journey of the climate impacts facing the places and people of British Columbia. The film was the impetus for a subsequent discussion on climate solutions that people could act on, and aspire to, with insights from the panelists; Frank Brown the hereditary chief of Heiltsuk First Nation, Victoria Mayor Lisa Helps, environmentalist David Suzuki, Ian Mauro and PICS Executive Director, Sybil Seitzinger.



TOP: Frank Brown, hereditary chief of Heiltsuk First Nation.
ABOVE: The panel sharing insights in front of a packed Farquhar Auditorium.



PICS STRENGTHENING WORKSHOPS

Strengthening workshops are a new offering under the PICS Research Engagement Program aimed at expanding the scope and impact of select Theme Partnership pre-proposals, before applicants submit a full proposal. The workshops bring together PICS staff, researchers and solution seeking partners to refine and strengthen project goals, objectives and intended outputs. Three strengthening workshops for three proposals were held in 2019, with the Solid Carbon project securing the \$1 million award.



AGENTS OF CHANGE – UC3 SUMMIT

The University of British Columbia, in partnership with PICS, hosted an in-depth conversation between University of California President and former US Secretary of Homeland Security Janet Napolitano and UBC President and Vice-Chancellor Santa Ono on the role that universities should play on global issues like the climate crisis. More than 300 people attended the event, held on July 22, 2019.



University of California President Janet Napolitano and UBC President and Vice-Chancellor Santa Ono.



OUR PEOPLE

Meet the team driving the PICS engine at the University of Victoria central office, and at the University of British Columbia, Simon Fraser University and the University of Northern British Columbia.

PICS staffing strengths continued to evolve in 2019. Our first Researcher-in-Residence Hannah Teicher joined the team as did PICS' first Program Manager at UVic, Kristy Facer, who has been carving a niche in climate solutions leadership at the university.

Michelle Connolly, PICS UNBC Program Manager, is on a one-year leave working with the BC Assembly of First Nations. Michelle is providing valuable technical and strategic support for First Nations-led climate, carbon and conservation projects, and will return in late 2020.



Michelle Connolly,
PICS UNBC Program Manager

PICS is proud to note the global recognition of our executive director Sybil Seitzinger, who was elected as a Fellow of the American Geophysical Union (AGU) in December 2019 for her research on the human impacts on the biogeochemistry of the Earth system and for inspiring policy solutions. Only 0.1% of AGU membership receives this recognition in any given year. Also in 2019, Sybil Seitzinger was chosen as the recipient of the prestigious 2020 A.C. Redfield Lifetime Achievement Award by the Association for the Sciences of Limnology and Oceanography (ASLO). This award honors major, long-term achievements in the fields of limnology and oceanography, including research, education, and service to the community and society.

THE HOME TEAM



Sybil Seitzinger
Executive Director



Ged McLean
Associate Director



Hannah Teicher
Researcher-in-Residence
Built Environment



Robyn Meyer
Senior
Communications
Officer



Nancy Chan
Executive Assistant

FIELD AGENTS



Kristy Facer
Program Manager,
University of Victoria



**Nastenka Calle
Delgado**
Program Manager,
Simon Fraser
University



Sara Muir Owen
Program Manager,
University of
British Columbia



Michelle Connolly
Program Manager,
University of
Northern British
Columbia



2019 BY THE NUMBERS

A snap shot of our 2019 investments in research, people, results and outreach.

4296 TOTAL LIVE AUDIENCE AT WORKSHOPS, SEMINARS, AND LECTURES THAT PICS PRIMARILY SPONSORED (CY 2019)

27 JOURNAL ARTICLES PUBLISHING PICS-FUNDED RESEARCH (CY 2019)

30 FACULTY MEMBERS AWARDED RESEARCH FUNDING SUPPORT (CY 2019)

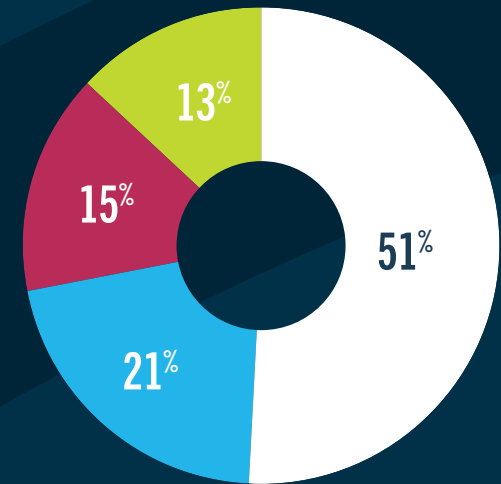
11 COMPANIES, GOVERNMENT MINISTRIES, OR ORGANIZATIONS EMPLOYING PICS INTERNS (CY 2019)

36 GRADUATE STUDENTS AND POSTDOCTORAL FELLOWS (FY 2019)

348 TRADITIONAL MEDIA ARTICLES ABOUT PICS RESEARCH, PLUS TV AND RADIO INTERVIEW (CY 2019)

190% INCREASE IN TWITTER FOLLOWER INTERACTIONS FROM JAN-DEC, 2019. AUDIENCE GROWTH ACROSS ALL PLATFORMS (FACEBOOK, TWITTER, AND LINKEDIN)

65% INCREASE IN AVERAGE TOTAL POST REACH ON FACEBOOK FROM JAN-DEC, 2019



● Research
\$1,398,09

● Administration
\$564,630

● Communications
\$425,754

● Intercampus Coordination
\$364,860

TOTAL EXPENDITURE
\$2,753,342



ROLL CALL

The following individuals led PICS projects in the calendar year 2019, either as researchers or supervisors of masters or PhD students.

Jonn Axsen

School of Resources and Environmental Management, SFU

Majid Bahrami

School of Mechatronic Systems Engineering, SFU

Stephanie Chang

Institute for Resources, Environment and Sustainability/ School of Community and Regional Planning, UBC

Curran Crawford

Institute for Integrated Energy Systems, Uvic

Ned Djilali

Institute for Integrated Energy Systems, Uvic

Dave Goldberg

Lamont-Doherty Earth Observatory, Columbia University

Bradford Griffin

Canadian Energy and Emissions Data Centre, SFU

Omar Herrera

Clean Energy Research Centre, UBC

Kasun Hewage

School of Engineering, UBCO

Mark Jaccard

School of Resource and Environmental Management, SFU

Ron Kellett

School of Architecture and Landscape Architecture, UBC

Werner Kurz

Pacific Forestry Centre, Natural Resources Canada

Zoe Long

Clean Energy Research Centre, SFU

Madeleine McPherson

Department of Civil Engineering, Uvic

Walter Merida

Clean Energy Research Centre, UBC

Mehrdad Moallem

School of Mechatronic Systems Engineering, SFU

Kate Moran

Ocean Networks Canada, and School of Earth and Ocean Sciences, Uvic

Angelique Pilon

UBC Sustainability Initiative, UBC

Bryson Robertson

Oregon State University/UVic

Andrew Rowe

Institute for Integrated Energy Systems, Uvic

Adam Rysanek

School of Architecture and Landscape Architecture, UBC

Anne Salomon

School of Resource and Environmental Management, SFU

Oliver Schmidtke

Centre for Global Studies, Uvic

Maged Senbel

School of Community and Regional Planning, UBC

Kara Shaw

School of Environmental Studies, Uvic

Oscar Venter

Conservation Solutions Lab, Forest Ecology and Management, UNBC

John Welch

Resource and Environmental Management, SFU

Peter Wild

Institute for Integrated Energy Systems, Uvic

David Zandvliet

Institute for Environmental Learning, SFU

Kirsten Zickfeld

Department of Geography, SFU



COMING SOON... WILDFIRE AND CARBON

PICS is looking to 2020 with exciting new projects, research exploration and climate change solutions being tackled by our talented, multidisciplinary teams of Research Partners and Solution Seekers. Keep in touch by signing up on our website for PICS news, announcements and events, and by following us on [LinkedIn](#), [Twitter](#) and [Facebook](#).

Credit: BC Wildfire Service (2018)

