

Summary

I grow single-celled slime molds to develop **more resilient cities** and I study microscopic sea creatures to design **zero-energy buildings**. The related, published research that I've led has been featured by **100+** media outlets, journals, and advisory toolkits worldwide like **Nature** and **Bloomberg**, while earning me **30+** prestigious awards/distinctions/fellowships (worth **>\$1M**) in renewable energy and sustainability.

I've been invited to speak about my work on a range of podcasts/radio shows like **CBC** and **Learning from Nature**, and to design/research teams at places like **NASA**. In addition, I have been **commissioned** to write about the implications of my research by international magazines, and I have been asked to **develop policy** with international governments and speak to **Presidential/Prime Ministerial** delegations worldwide. As a manager, I have mentored over **two dozen students**, from undergraduate design projects to award-winning global sustainability proposals.

Education (interdisciplinary training that shaped my focus on creative/unconventional innovation for social impact and sustainability)

2023/28 **Ph.D.**, Materials Science & Mechanical Engineering, Harvard University, Mentored 9+, 4.0/4.0, 7 Awards/Distinctions
 2020/22 **M.A.Sc.**, Mechanical Engineering, University of Toronto, Mentored 10+, 4.0/4.0, 10+ Awards, Top Thesis, Rank: 1/89
 2016/20 **B.A.**, Architectural Technology, University of Toronto, 3.95/4.0; 15+ Awards, Top Graduate, Rank: 1/230

Selected Awards/Honors (30+, >\$1M USD total, in recognition of academic excellence, creative innovation, humanitarian contribution)

2024 **Department of Defense** Graduate Fellowship (~\$300k, top ~4% of applicants)
 2024 **Link Energy** Fellowship (~\$70k, top ~4% of applicants)
 2024 **Canada** Graduate Scholarship, Doctoral (~\$100k, top national STEM doctoral fellowship, declined)
 2024 **Trudeau** Scholarship (~200k, top national humanities doctoral fellowship, top ~3% of applicants, declined)
 2024 **Chen** Harvard Graduate Fellowship (top ~0.5% of faculty)
 2024 **NSERC** Postgraduate Scholarship (~60k, pending acceptance)
 2023 **Stanford** Graduate Fellowship (\$300k, declined, top ~0.8% of applicants)
 2022 **Berkeley** Fellowship (\$70k, declined, top ~1% of applicants, singular recipient)
 2022 **Top graduate thesis** in department (top ~1% of class, singular recipient)
 2022 **Hatch** Sustainability Scholarship, Institute for Sustainable Energy (\$10k)
 2022 **MITACS** Research Award (\$6k, declined)
 2022 **Hogg** Energy Fellowship (\$10k/year, renewable for three years, declined)
 2021 **Canada** Graduate Scholarship (\$17.5k, top ~0.4% of national graduate student body)
 2021 **Ontario** Graduate Scholarship (\$15k, declined, top ~1% of provincial graduate student body)
 2021 **Bowman** Energy/Environment Scholarship, Centre for Global Engineering (\$5k)
 2021 **Wasmund** Sustainable Energy Fellowship (\$1.2k)
 2020 **Top Faculty Prize** (top ~0.4% of class, ranked first in graduating faculty)
 2019 **Leaders of Tomorrow** Award (\$2.5k, top ~0.4% of class, singular recipient)
 2019 **U of Toronto** Scholar (\$1.5k, top ~4% of undergraduate class)

Selected Fellowship Finalist Distinctions

2024 **Hertz** Fellowship *Finalist* (selected as top ~5% of applicants)
 2023 **Knight Hennessey** Scholarship *Finalist* (selected as top ~2% of applicants)
 2022 Governor General's **Gold Medal Nominee** (selected as top ~0.1% (~30/20 000) of graduate student body)
 2020 Governor General's **Silver Medal Nominee** (selected as top ~0.03% (~20/15 000) of undergraduate student body)
 2019 **Rhodes** Scholarship *Finalist* (top ~0.01% (13/~100 000) of provincial student body, sole nominee (1/~15 000) from university)

Selected Research Activities (5+ labs in 3 countries, shaping my vision at the intersection of biology, engineering, environment, and policy)

2023- PhD Student, leading team of 5+ to develop **0-energy building skin** using mostly **water**, Harvard University, Prof. Aizenberg.
 2022/23 Research Fellow, developed **first material to universally manipulate a beam of sunlight**, Harvard University, Prof. Aizenberg.
 2022/22 Visiting Researcher, helped develop bacteria **living solar panels**, Hub for Biotechnology in the Built Environment, Dr. Sawa.
 2022/22 Visiting Fellow, fused fluidics + photonics to develop class of **low-energy liquid windows**, Harvard University, Prof. Aizenberg.
 2020/22 MAsc Student, led team of 4 to develop new **fish-inspired platform** for **0-energy buildings**, U Toronto, Prof. Hatton.
 2020/21 Researcher, led team of 3 to develop **slime-mold-inspired city design tool**, U Toronto, Prof. Hatton.
 2020/20 NSERC Research Award, used **75-cent oil** to make **self-regulating**, sustainable **liquid window**, U Toronto, Prof. Hatton.
 2019/20 Undergrad researcher, designed project to address **diff between** perceived/measured **air quality**, U Toronto, Prof. Robinson.
 2019/20 Undergrad researcher, co-designed autonomous **robot self-propelled by humidity**, U Toronto + U Waterloo, Prof. Correa.
 2019/19 Selected Student, **chosen to represent Canada** in multinational **water resiliency program**, Delft University of Technology.
 2019/19 NSERC Research Award, developed the idea to integrate **light-guiding veins in windows**, U Toronto, Prof. Hatton.
 2018/19 NSERC Research Award, assisted filter forensics experiments to **rethink air quality measurements**, U Toronto, Prof. Siegel.
 2017/17 Volunteer, led outreach for **social-impact environmental design**, Public Architecture, San Francisco (remote work).

First-Author Publications (*indicates peer-reviewed academic publication on which I served as lead, corresponding author)

- 2023 Kay. What color-changing crustaceans can teach us about designing efficient buildings. **Invited/commissioned article**. [Ar. Aktl.](#)
- 2023 Kay et al., *Multilayered optofluidics for sustainable buildings. [PNAS](#), 30+ features/interviews.
- 2022 Kay et al., *Decapod-inspired pigment modulation for active building facades. [Nature Comm.](#), 30+ features/interviews.
- 2022 Kay et al., *Stepwise slime mould growth as a template for urban design. [Scientific Reports](#), 25+ features/interviews.
- 2022 Kay et al., *Shape-programmable fluid bubbles for responsive building skins. [J. of Building Engineering](#).
- 2022 Kay et al., *Programmable droplets: Leveraging digitally-responsive flow fields to actively tune liquid morphologies. [PLoS One](#).
- 2020 Kay et al., *The bio-inspired design of a self-propelling robot driven by changes in humidity, in [eCAADe](#), 5 features/interviews.

Selected Intellectual Property (ideas that I invented/co-invented toward a more sustainable future)

- 2024 Kay et al. A fluidic system for climate control. PCT filed May 10, 2024.
- 2022 Kay et al. System for control of optical properties of light. U.S. Patent filed November 29, 2022. U.S. 18071496.
- 2022 Kay et al. Fluidic device for regulating light transmission through the device. PCT Filed November 29, 2022. CA2022/051747.

Selected Invited Academic/Governmental Presentations (to recognize impact of my research and teach the broader public community)

- 2024 Fish-inspired buildings and slime-inspired cities. **Invited conference speaker**, Bioinspired Materials and Design Conf., Toronto.
- 2024 Slime City. **Invited presenter** to highlight my slime-inspired sustainable city design tool, **World Governments Summit**, Dubai.
- 2022 Could the future be fluidic? **Invited seminar speaker** to share my 0-energy liquid window concept, **Yale University**.
- 2022 Unicellular city planners for the moon. **Invited speaker** to ignite collaborative pilot-study, Lunar Habitat Design Team, **NASA**.

Selected Academic Presentations (to ignite collaboration with the scientific community)

- 2023 Optofluidic skins for sustainable buildings, in *Soft Optics*, 2023 Materials Research Society Fall Meeting.
- 2021 Slime mould networks as a template for the design of cities, in *Sustainability and Water*, U Toronto Eng. Research Conf.
- 2021 Biological microfluidics for smart buildings, in *Functional and Emerging Materials*, Canadian Materials Science Conf.
- 2020 From pinecones to robots, in *Cognizant Architecture - What if Buildings Could Think?*, eCAADe Conference.

Selected Interviews and Radio Show/Podcast Appearances (40+, recognizing social and environmental impact of my research, more [here](#))

- 2023 Could seafood-inspired skins slash emissions from buildings? Interviewed for: [CBC What On Earth with Laura Lynch](#).
- 2023 How Does Nature Modify Light and Color? With Raphael Kay. *Learning from Nature: The Biomimicry Podcast*. [Apple](#). [Spotify](#).
- 2023 "The future of construction is liquid," claims a Harvard researcher. [Habitability](#).
- 2023 'Liquid windows' inspired by squid skin could help buildings react to changing environments. [University of Toronto](#).
- 2023 'Liquid windows' could be the answer to more sustainable buildings. [Fast Company](#).
- 2023 Using Fluids to Control Energy Use in Buildings. [American Society of Mechanical Engineers](#).
- 2023 Chameleon Skins Slash Building Energy Use. [IEEE Spectrum](#).
- 2022 A Green Building Technique, Inspired by Fish Food. [Bloomberg News](#).
- 2022 One Solution to the Climate Crisis is a Pane in the Glass. [H2O Radio](#).
- 2022 These color-changing, energy-saving windows are inspired by an unlikely sea creature. [Fast Company](#).
- 2022 Skin: the next frontier? [Novae Res Urbis, Toronto Edition](#).
- 2022 What slime mould can teach us about optimizing the TTC. [The Varsity, University of Toronto](#).

Selected Research Features in Academia/Popular Media (75+, recognizing social and environmental impact of my research, more [here](#))

- 2023 Optofluidics-based climate control in buildings. Research Highlight, [Proceedings of the National Academy of Sciences](#).
- 2023 Squid-inspired smart windows could slash building energy use. [Anthropocene](#).
- 2023 Optical tuner for sustainable buildings. Research Highlight, [Nature Communications Engineering](#).
- 2023 Pigmented fluids. Included in the Biomimicry Design Toolkit, [bioSEA](#).
- 2022 Sea creatures' sunshades inspire low-cost 'smart' windows. Research Highlight, [Nature](#).
- 2022 The Krill Building. [Bloomberg Navigator](#).

Selected Mentoring and Coaching (30+ students, some of whom I hope to have inspired)

- 2022- High-school level: Germantown Friends School; St. John the Baptist High School; Undergraduate level: Carnegie Mellon University, Boston University, Harvard University; Graduate level: University of California; Rajk College for Advanced Studies.

Selected Academic Review Positions

- 2022- Environment and Planning B: Urban Analytics and City Science.

Leadership Activities and Achievements (where I picked up many of the team/management skills I practice today)

- 2013- High-school: Appointed **captain** of junior, **co-captain** of senior basketball team; **most valuable player** of junior basketball team; volunteer basketball **coach**; senior basketball **counselor/coach**, provincial basketball player, culture club **president**. Undergraduate/graduate: faculty orientation **leader**, recruitment **leader**, intramural basketball, dodgeball team **captain**.