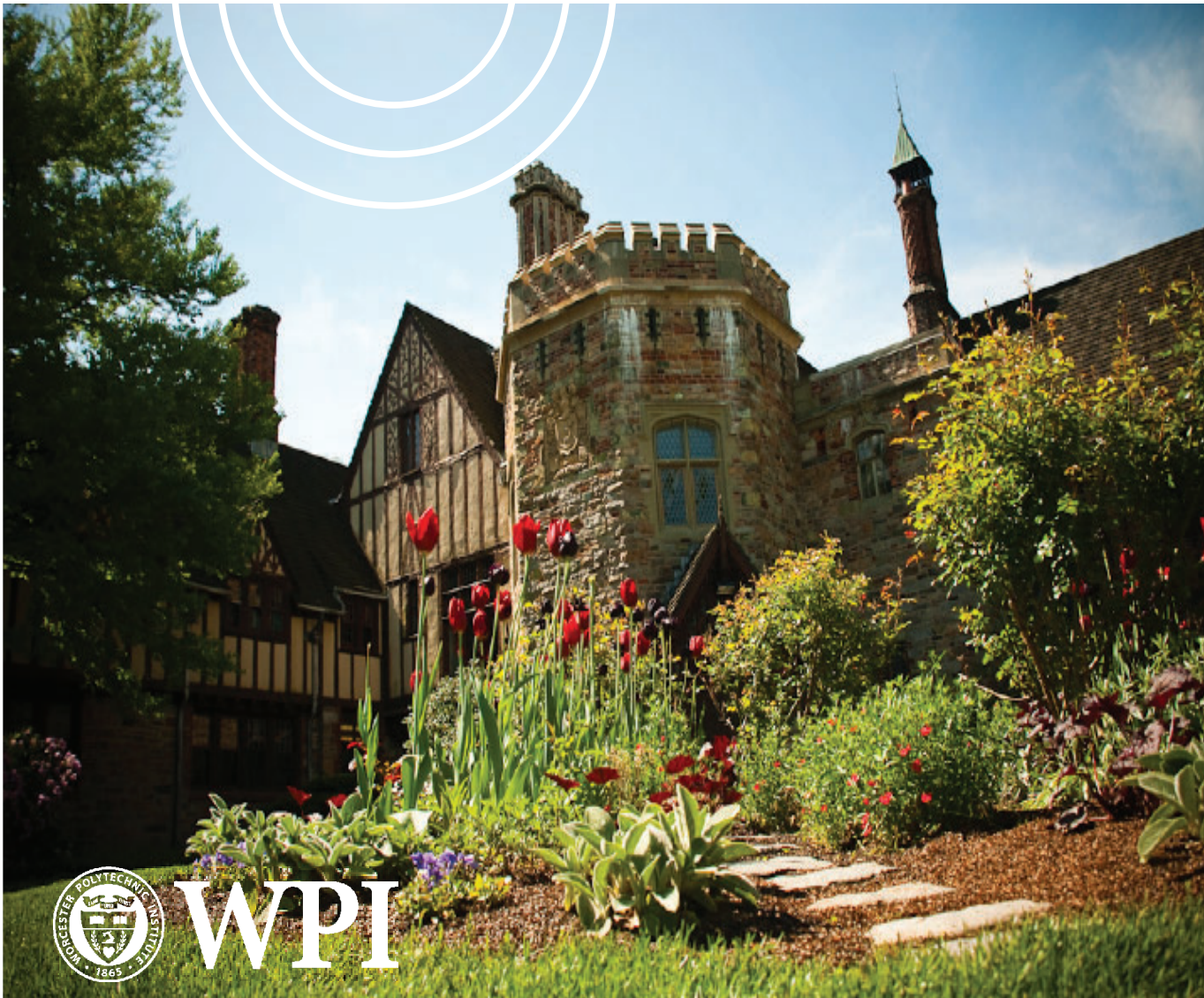**2020-2021**

SUSTAINABILITY REPORT

WORCESTER POLYTECHNIC INSTITUTE
100 Institute Road
Worcester, MA

TABLE OF CONTENTS

ABOUT SUSTAINABILITY

For the building you live in, the clothes you wear, and the food you eat to be sustainable means that those items have a past, present, and/or future in balance with the economy, equity, and environment. By being sustainable, your actions have the potential to meet your needs without hindering the capability of future generations to meet their own needs. No matter who you are, sustainability is important to you. Before you existed, your ancestors learned how to transport water from its source to their drinking cups using irrigation, and how to develop medication and vaccinations to cure our illnesses and subdue our pain. The discoveries of our ancestors improved the quality of our lives. Why shouldn't we want the same for our future generations The discoveries of our ancestors improved the quality of our lives, why shouldn't we want the same for our future generations?

Working in a New Normal

The COVID-19 pandemic covered the entirety of the fiscal year from July 1st, 2020 until June 30th, 2021. This certainly had a signicant impact on the activiies and programs throughout the year. Likewise, the "new normal" of this fiscal year had an impact on WPI's quest towards the sustainability goals. From decreased travel due to remote learning to increased waste from COVID-19 test kits and to-go containers, WPI's community as well as the world underwent a great shift in lifestyle. The effect our "new normal" had on our global climate is a reason to keep in mind for changes in various aspects of sustainability at WPI. We look forward to a transition back to a normal with more on-site and in-person activities.

WPI'S SUSTAINABILITY PLAN

In 2020, WPI developed a sustainability plan with a set of goals and objectives to meet by 2025. It is important to WPI to meet their sustainability principles on campus, locally around Worcester, and globally, therefore it is best to think of WPI's sustainability efforts as an ecosystem. This ecosystem represents a multi-disciplinary framework that is aligned to meet local, regional, and global challenges in sustainability. It includes three primary initiatives:

(1)   advancing sustainability within our campus as a living and learning laboratory,

(2)   advancing sustainability locally by expanding our efforts beyond our campus and developing the local community and region as a hub for sustainability innovation, and

(3)   advancing sustainability globally by reaching out beyond our campus (locally, regionally, and globally) to develop our academic initiatives that impact communities worldwide.

These complementary initiatives allow for sustainability advances that will provide for beneficial local and global impact. We are looking forward to advancing these initiatives.

WPI'S Sustainability Ecosystem

To meet the needs of the present without compromising the ability of WPI and beyond to meet their needs in the future, it is important to consider the three pillars of sustainability in many areas, such as:

Energy   Waste   Water   Health   Environment   Food   Urbanization

ACADEMICS

As a university concentrated in project-based work, unsurprisingly many courses contain one or more aspects of sustainability. WPI acknowledges that the path to a more sustainable future lies in spreading education and awareness to the public. A plethora of courses, majors, minors, and concentrations allow students to costomize their learning to their specific interests.

SDGs

To assist in understanding and tracking how WPI's courses relate to sustainability, WPI is incorporating the 17 sustainable development goals (SDGs) developed by the United Nations. These goals include:

No Poverty

Hunger

Good Healh & Wellbeing

Quality Education

Gender Equality

Clean Water & Sanitation

Affordable & Clean Energy

Decent Work & Economic Growth

Industry, Innovation, & Infastructure

Reducing Inequality

Sustainable Cities & Communities

Responsible Consumption & Production

Climate Action

Life Below Water

Life on Land

Peace, Justice, & Strong Institutions

Partnerships for the Goals

Most of WPI's projects integrate at least one of these goals. To learn more about how each goal relates to sustainability and its importance to WPI, visit WPI's Sustainability Living and Learning Laboratory (SL3) WEBPAGE.

Sustainability-related Courses

Increasing courses and projects related to sustainability is a integral part of WPI's sustainability plan. Many of WPI's courses include topics pretaining to sustainability.

119 Undergraduate 30 Graduate

Courses related to sustainability.

Of those courses,

| 12 | Departments with at least 1 course focused in sustainability |
| 20 | Departments with at least 1 course inclusive of sustainability |

Sustainability can and often does branch across other disciplines, weaving into the framework of WPI's projects and courses. These courses may be focused in sustainability or simply include sustainable concepts. Sustainability-focused courses primarily teach sustainability topics while sustainability-inclusive courses include sustainability topics in relation to the main course information.

COURSE EXAMPLES

Sustainability-Focused	Sustainability-Inclusive

CHEMICAL ENGINEERING

Sustainability-Focused	Sustainability-Inclusive
RESILIENT INFRASTRUCTURE FOR A CHANGING CLIMATE - Undergraduate ENERGY CHALLENGES IN THE 21ST CENTURY - Undergraduate	BIOENERGY - Undergraduate UNIT OPERATIONS OF CHEMICAL ENGINEERING II - Undergraduate FUEL CELL TECHNOLOGY - Graduate

ARCHITECTURAL ENGINEERING

Sustainability-Focused	Sustainability-Inclusive
BUILDING ENVELOPE DESIGN - Undergraduate BUILDING ENERGY SIMULATION - Undergraduate	ARCHITECTURAL DESIGN IV - BUILDING ENERGY SIMULATION - Undergraduate PRINCIPLES OF HVAC DESIGN FOR BUILDINGS - Undergraduate FUEL CELL TECHNOLOGY - Graduate

BUSINESS

Sustainability-Focused	Sustainability-Inclusive
GLOBAL ENVIRONMENT OF BUSINESS DECISIONS - Undergraduate INTRODUCTION TO CORPORATE SUSTAINABILITY - Undergraduate ENERGY MANAGEMENT - Graduate BUSINESS LAW, ETHICS AND SOCIAL RESPONSIBILITY - Graduate	GLOBAL PLANNING AND LOGISTICS - Undergraduate SOCIAL ENTREPRENEURSHIP - Undergraduate LEAN PROCESS DESIGN - Graduate RISK MANAGEMENT AND DECISION MAKING - Graduate

BIOLOGY AND BIOTECHNOLOGY

Sustainability-Focused	Sustainability-Inclusive
ENVIRONMENTAL BIOLOGY - Undergraduate ECOLOGY, ENVIRONMENT, AND ANIMAL BEHAVIOR - Undergraduate ENVIRONMENTAL CHANGE: PROBLEMS & APPROACHES - Graduate BUSINESS LAW, ETHICS AND SOCIAL RESPONSIBILITY - Graduate	BIODIVERSITY - Undergraduate PLANT DIVERSITY - Undergraduate BIOINFORMATICS - Graduate STATISTICAL ANALYSIS IN GENETICS AND BIOINFORMATICS - Graduate FERMENTATION BIOLOGY - Graduate

Some Events

WPI faculty members occasionally hold presentations open to all students and the WPI Community in which they share their knowledge on current socia, economic, or environonmental issues and events. Usually the faculty give their seminar in a lecture hall but, due to the pandemic, most presented online. Some such conferences include the Global School Event Series and Green Talks.
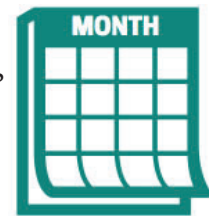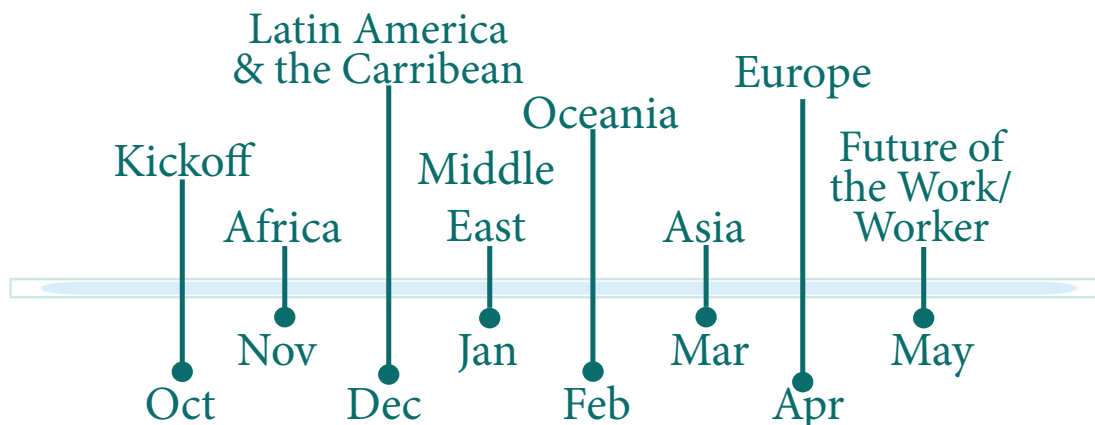
Global School

Event Series

In honor of its new Global School created in February 2020 by the Provost's Office, WPI held a global school virtual event series. There are events for multiple regions and countries, with accessible video recordings for each event. The series includes events for Africa, Asia, Europe, Latin America, and Oceania.

Each event celebrated a different region monthly throughout the 2020-2021 academic year. There is also the Future of Work event investigating the future perspective of work and the role technology may play as well as an event dedicated to WPI's 2020-2025 Sustainability Plan. To start off the series in October 2020, many talks provided an in-depth look of the new school from its founders and greatest supporters as well as the perspective of Institute Professor at Massachusetts Institute of Technology, Robert Langer, as he described the challenges that he faced to solve global health issues. More information as well as recordings from the event can be found on WPI's Global School Virtual Event Series page.

Monthly Events

Kickoff — Oct

Africa — Nov

Latin America & the Carribean — Dec

Middle East — Jan

Oceania — Feb

Asia — Mar

Europe — Apr

Future of the Work/ Worker — May

Kickoff Event
Introduction to the virtual celebration and university lecture with a session on global challenges.

Africa Event
An event celebrating WPI's partnerships with groups at work in sub-Saharan Africa. Multiple talks about the Science and Technology work WPI did and continues to do in sub-Saharan Africa.

Latin America and the Carribean Event
This event included talks from students and faculty who've done and continue to do research in Latin America and the Caribbean as well as provide testimonials regarding WPI's project centers there. Presenters explained challenges facing the region including the health crisis and slow conversion of the rainforest into dry land.

Middle East Event
The purpose of this event was to raise awareness for WPI projects to include middle eastern territories by highlighting student projects with student presenters Pooja Patel, Kyla Egenberger, Omar Algarni, and Rafael Pimentel as well as an address by Malak Al-Akiely, CEO of Golden Wheat for Grain Trading.

Oceania Event
The speakers for this event shared an in-depth review of WPI's project centers there as well as climate change, nature and society, and indigeneity of Oceania. Talks include speakers Mele Wendt from New Zealand and Holger Droessler from WPI's History department.

Asia Event
Presentors spoke about faculty and student research projects. There was also an address from Meng Bo, Associate Dean of the Office of International Affairs at Tsinghua University regarding surfacing issues as Asia develops higher education.

Europe Event
Talks from many members of the WPI community including alum, faculty, and partners. The panelists discussed what the future of business in Europe may look like after the pandemic and circular economy.

Future of the Work/Worker Event
Unlike the previous events, this event looked at what the general role of work will be and how the worker may change with new technological advancements. Dean Kamen spoke about the importance of a global STEM education and why we should provide young people with the opportunity to build innovation skills.

Green Talks

Hosted by WPI's Green Team, Green Talks provided an opportunity for students of any major to learn more about what WPI professors do to make the world a more sustainable. The guest speakers consisted of Professor Ingrid K. Shockey, Professor Marja Bakermans, Professor Aaron R. Sakulich, Professor Roger S. Gottlieb, Professor Paul P. Mathisen, and Professor Roger S. Gottlieb.

Each professor gave an approximately 15-30-minute talk sharing their knowledge about a sustainability-related topic as well as their experiences with it.

At the end of each talk, students had the opportunity to ask the speakers questions and hear their answers.

The Green Team spread the word through flyers and emails.

The Green Talks Program was held on Apriil 30th over Zoom with students from the Green Team and others from a variety of majors.

Each professor part of Green Talks holds a different area of expertise in relation to sustainability, providing students attending the entire Green Talks session a diverse insight into sustainability.

Prof. Marja Bakermans	Prof. Aaron Sakulich	Prof. Roger Gottlieb	Prof. Paul Mathisen	Prof. Rob Krueger	Prof. Ingrid Shockey
12PM EST	12:30PM EST	1PM EST	1:30PM EST	2PM EST	2:30PM EST
Persistence in Conservation	Building Materials and Environment	Guilt, Responsibility, and the Environmental Crisis	Sustainable Water Resources: Thinking Blue	Why Should We Look to Sub-Saharan Africa about Sustainable Development	Recording the Voices of Climate Change

PROJECTS

Over the course of each student's four years at WPI, they complete numerous projects. Most notably are the Interactive Qualifying Project (IQP) done during their Junior year and the Major Qualifying Project (MQP) done during their Senior year. Incoming Freshmen also have the option to choose a Global Projects Seminar (GPS) course their first year. Most of these projects overlap in some way with sustainability.

GPS

The Great Problem Seminar (GPS) is an optional two-term course available to first-year students introducing them to WPI's project-based learning style and allowing them to choose a current global concern to research. This year there were 10 GPS courses:

Extinctions: Who Will Survive?

Ignorance is not Bliss

Heal the World

Livable Cities

Climate Change

Power the World

Seeking Sustainability

Shelter the World

Humanitarian Engineering

Recover, Reuse, Recycle

GPS PROJECT EXAMPLES

Extinctions: Who Will Survive?
The Keystone of the Tundra: Preemptively Protecting the Artic Fox
by Tristan Andrew, Chase BeauSoleil, Alex Davidson, Ciara Moroney

Livable Cities
Moscow's Waste-Land
by Charles Anderson, Jack Lafond, David MacLeod, Adam Tedesco

Seeking Sustainability
Preventing Harmful Algae Blooms Due to Run-off in Worcester, MA
by Joseph Fox, Finnian Hamblett, Danny Ngo, Grace Porier

Heal the World
Mitigating Search and Rescue in Yosemite National Park
by Scarlett Clarke, Justin Huang, Samuel Ott, Taylor Wood

Recover, Reuse, Recycle
The Trash Cache
by Zoe Swartley, Joseph Caponigro, Luke Regan, Ethan Vaz Falcao

Power the World
Pumped Hydropower
by Joshua Barney, Zachary Maynard, Morgan Raposa

Winners by Course

Extinctions: Who Will Survive?
The Red Lionfish and their Effect on Native Fish Populations
by Kayla Carpenter, Cat Garcia, Cameron Norton

Livable Cities
Greener Istanbul
by Achilles Gikas, Kyra Freeman, Samuel Appiah Kubi, Kosti Pano

Climate Change
Small Scale Carbon Capture Utilization and Implementation
by Gabriel Espinosa, Jack Hanlon, Alexander Wadsworth

Humanitarian Engineering
Thinking Outside the Well: Addressing Water Scarcity in Rural Morocco
by Kerry Bushway, Jacob Schools, Grace Solod, and Jena Taubert

Seeking Sustainability
Paving a Path for Public Transit
by Elliot Dunham, Max Frail, Natanel Pinkhasov, Nina Quattromani

People's Choice: Heal the World
Therapy Limitations for Children with Late-Onset Pompe Disease
by Natalie Tierney, Komlavi Touglo, Roshini Uthayakumar, Nicholas Uy

Shelter the World
Kibera: Reblocking Kenya's Largest Slum
by Habeeb Ismail, Bryce Kennedy, Eric Montiverdi

Ignorance is Not Bliss
Mentoring to Increase Sixth Graders' Technological Literacy
by Alexandra Ballentine, Ronit Banerjee, Ngoc Pham, Oliver Shulman

IQP

The Interactive Qualifying Project (IQP) is a nine-credit project typically completed during a student's junior year in which student teams from different majors collaborate on relating STEM topics to the society around them. These projects can be either on campus or at one of over fifty different project sites around the globe. In 2020 there were over 30 sustainability related IQPs.

PRESIDENT WINNER

"Memorialization of the Spaç Labor Camp: An Investigation into Digital Methods" by Michael Clements, Leo Gross, Elizabeth Kirschner, and Zetta Rajaniemi; Advisors: Professor Robert Hersh and Professor Robert Kinicki; Sponsor: Cultural Heritage without Borders

Finalist
"Using Behavior-Change Strategies to Reduce Littering in Lambeth"
Students: Ryan Johnson (CS), Paul Bonarrigo (BE), Matthew Iaconis (MIS), Brendan McCann (ME)
Advisors: John Orr and Paul Marrone
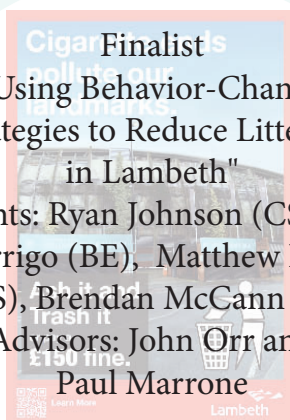
Finalist
"Jazz History Database Global Contributor Project"
Students: Mikel Matticoli (CS/IMGD), Lucas Varella (CS)
Advisor: Keith Zizza

Finalist
"Improving Emergency Preparedness in Monte Verde Costa Rica"
Students: Alejandra Garza (CS/IMGD), Dante Knight (CS), Nancy Nguyen (ME), James Witt (CS)
Advisors: R. Creighton Peet and William San Martin
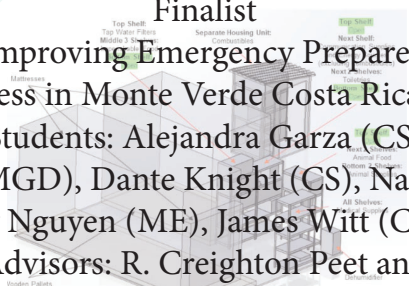
Finalist
"Assessing Opportunities to Reduce the Environmental Impacts Of Brewery Waste in Albania"
Students: Sarah Boermeester (BME), Marissa Gonzales (BME), Katy Jessop (CM), Griffin St. Onge (ME)
Advisors: Robert Hersh and Robert Kinicki
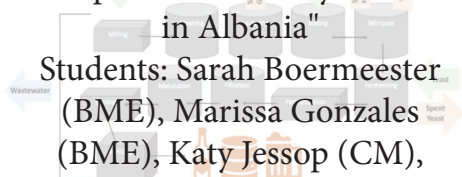
"Designing a Citizen Science Platform for Venice"
Students: Alvarado Blanco Uribe, Isabel C., Tess Flaherty, Frank J. D'Alessio, and Evan Davis
Advisors: Jennifer deWinter and Fabio Carrera
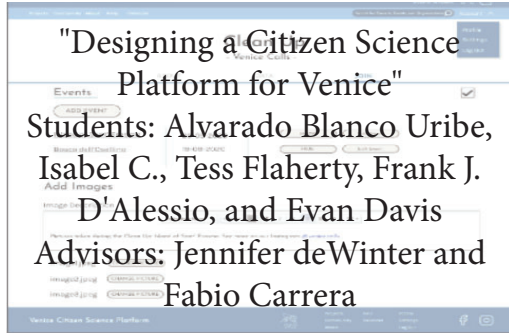
"Developing Criteria for Green Space Implementation on Vacant Lots in Massachusetts Cities"
Students: Samuel W. Ng, Jacob A. Mackenzi, and Brendan A. Russell
Advisors: Seth Tuler and Qingshuo Song
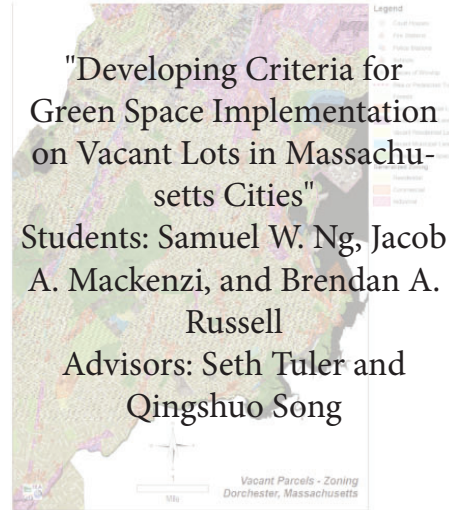
"Packaging Redesign and Information Accessibility for Semi-Direct Starter Cultures"
Students: Alek R. Hersum, Catina L. Schneck, Jyalu Wu, and Erich F. Schwarzrock
Advisors: Blake Hoag Currier and Ulrike Brisson

"Therapeutic Gardening"
Students: Matthew B. Adams, Ciara R. Young, Mairead E. O'Neill, Christopher R. Davenport
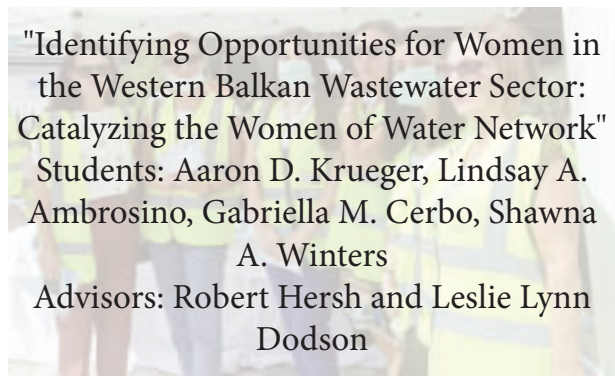Advisors: Scott J. Jiusto and Gbetonmasse B. Somasse

"Growing the H3 Ecosystem"
Students: Jessica M. Evans, Kathleen D. Cochran, Stephanie Tam, Madeline E. Hallie
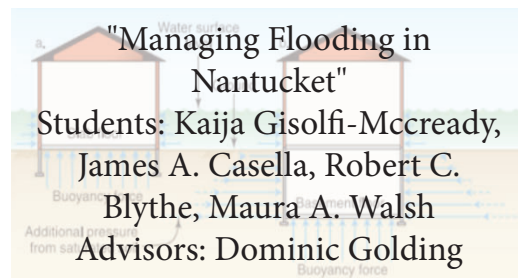Advisors: Fabio Carrera and Jennifer deWinter
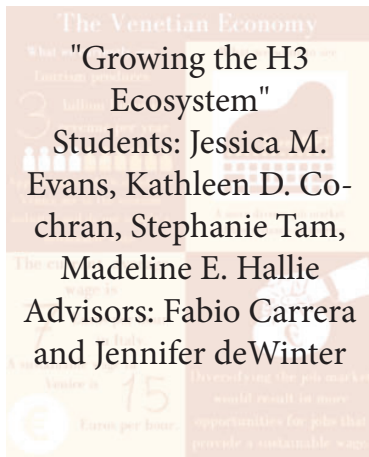
"Identifying Opportunities for Women in the Western Balkan Wastewater Sector: Catalyzing the Women of Water Network"
Students: Aaron D. Krueger, Lindsay A. Ambrosino, Gabriella M. Cerbo, Shawna A. Winters
Advisors: Robert Hersh and Leslie Lynn Dodson

"Assisting Glacier National Park in Achieving Full International Dark Sky Park Status"
Students: Sullivan J. Mulhern, Bridget Wirtz, Evan J. Buckley, Casey J. Gosselin, Larson H. Ost
Advisors: Frederick W. Bianchi and Fred J. Looft

"Managing Flooding in Nantucket"
Students: Kaija Gisolfi-Mccready, James A. Casella, Robert C. Blythe, Maura A. Walsh
Advisors: Dominic Golding

MQP
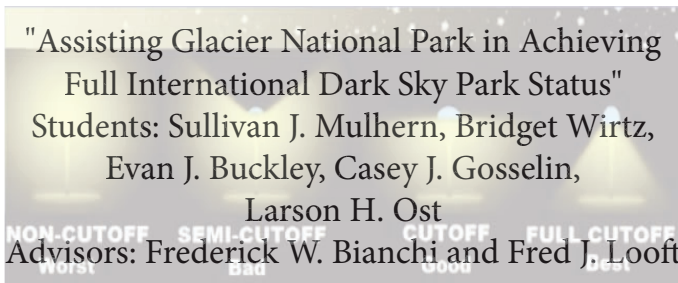
The Major Qualifying Project (MQP) is a nine-credit project during a student's senior year where individuals from the same or related majors complete a professional level research project in their field. While these projects are typically completed on campus, some are completed at global locations.

PROVOST'S AWARDS

Department:
Data Science
"Machine Learning for Mental Health Screening"
Students: Connor Bruneau, Hunter Caouette, Rimsha Kayastha, Veronica Melican, Miranda Hernandez-Reisch

Department:
International Development, Environment, and Sustainability
"Guyana Research Park Development Project"
Student:
Kristophe Zephyrin

Department: Mechanical Engineering
"Redesigned Shark Tagging"
Students: Brooke Dawson, Hannah Gallagher, Amelia Harvey, Lilly Nardelli, Aram Soultanian

Department:
Environmental Engineering
"Acid Leachate Active Treatment Pilot System for Cooledge Brook, MA"
Students: Emma E. Burleson, Annemarie N. Eastwood, Lauren O. Mitchell, Molly W. Youngs

Department:
Humanities & Arts
"Putting the "Other" Center Stage: Examining Modern Language and Nuances of Representation within Theatre"
Student: Olivia Lattanzi

Department: Civil & Environmental Engineering
"Northern Strand Community Trail On-Road Extension"
Students: Sarah E. Kwatinetz , Maggie A. Ostwald, Lily C. Spicer

OTHER SUSTAINABLE MQPs

"Creation of a Fish-Friendly Aquatic Hydropower Device Using an Oscillating Hydrofoil"
Students: Patricia S. Smith, Patrick Chernjavsky, Garrett B. Hughes, Victoria Niedźwiecki
Advisors: Brian James Savilonis

"Gompei's Lab Grown Leather"
Students: Alexa S. Eves, Alyssa Webb, Samantha K. Morton, Leah A. White, and Julia N. Premo
Advisors: George D. Pins and Glenn R. Gaudette

" Revealing Surface Changes in a Transparent Gallium Air Battery"
Students: Shayne M. Barton, Nicole Bodinizzo, and Donald T. Coley
Advisors: Pratap M. Rao and Andrew R. Teixeira

" A Stakeholder-Driven Approach to Sustainable Community Planning and Design"
Students: Jodi M. Kurilla and Seneca B. Warren
Advisors: Joseph Cullon, Mohamad Farzinmogha-dam, Robert Krueger

"Steps Towards Defossilization: Rethinking Petrochemical Production"
Students: Kyra R. Diederman, Katy E. Jessop, Shelby P. Morrison, Trey C. Sheridan
Advisors: Jennifer L. Wilcox

"Designing High School Computer Science Curriculum to Address Real-World Biologi-cal Problems with Computational Thinking"
Students: Kristen L. Hart
Advisors: Elizabeth F. Ryder and Carolina Ruiz

"Vineyard Robot"
Students: Kenneth Desrosiers and Sophie L. Antoniou
Advisors: Michael A. Gennert

"Wireless Wearable Core Body Temperature Sensor"
Students: Eric C. Baccei, Cameron B. Williams, and Eric Macorri
Advisors: Stephen J. Bitar and Ulkuhan Guler

"Pregnant Women's Experiences in the Workplace: Thematic Analysis and Recommendations for Im-provement"
Students: Ashley M. Danielson
Advisors: Angela C. Rodriguez, Adrienne Hall-Phillips, Renata Konrad, and Jeanine LM Skorinko

Sustainability Project Competition

Held yearly, the sustainability project competition specifically celebrates sustainability and welcomes projects of various types for entry, including GPS, IQP, MQP, and graduate projects. This year was WPI's 13th Sustainability Project Competition. This years winners by category are as follows:

1st Year

"   "

By Gabriel Espinosa, Alexander Wadsworth, Jack Hanlon
Advisors: Marja Bakermans, Geoffrey Pfeiffer, Sarah Strauss

Undergraduate

"   "

By Emilia Perez, Chase Gaudino, Lauren Kaija, Hannah Schulz, Trisha Worthington
Advisors: Suzanne LePage, Leonard Albano

~TIE~

Graduate

"   "

By Zahra Noori
Advisors: Jamal Yagoobi, Burt Tilley

"   "

By Munevver Elif Asar Sarikaya
Advisor: Jamal Yagoobi

~ Other Notable Entries ~

Undergraduate:
"Developing a Net-Zero Framework for the WPI Campus"
"Bioinspired Design of Novel Reinforced Concrete Elements"

Graduate:
"Unlocking the Full Potential of Waste-to-Energy by Investigating the Impact of Solvent Extractions on Hydrothermal Liquefaction"
"Optimized Metals Separation for Remanufacturing of Product-Centric Recycled and Reclaimed Scrap"
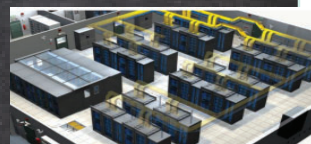
Research

Each year, WPI faculty members and students perform research in a variety of subject areas. Awards and grants to WPI make it possible for many of the professors and students to accomplish their research. In 2020-2021, WPI received more than 40 research grants, totaling more than $20 million in research funding, To provide a few examples, this section includes sustainability-related research for a few WPI faculty members, including Professors Bhada from the Electrical and Computer Engineering, Professor Elgert from Social Science and Policy Studies, Professor Lui from Civil and Environmental Engineering, and Professor Stanlick from International and Global Studies Division.
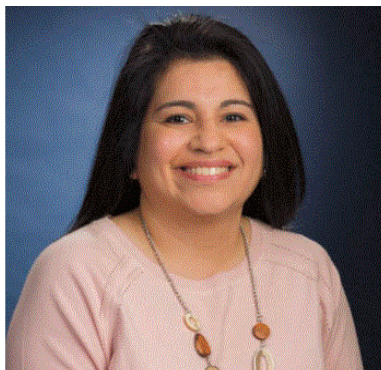
Professor Shamsnaz Virani Bhada

Professor Bhada's latest research involves examining environmental policies of public organizations and identifying missing information in those policies as well as how they relate to environmental impacts.

Through her research, Professor Bhada discovered that planning gaps are a common problem in environmental policy. There is a tendency for organizations to verabilize that they will accomplish some standards but they are missing traceability or a set plan of action towards achieving the goal. Bhada's work involves collaborative efforts to help policy makers address these issues. Solutions may not just involve adding more details to plans, but sometimes may change the way the goal is presented all together. By transitioning to a systems approach with a model-centric system, policies may be more effective. Bhada and her teamhave produced a software code for a model-centric framework that includes an new approach for Policy Content Modeling and Analysis. Her next steps involve applying the framework to policies influencing public transportation in midlevel cities. The policy metric will qualtative and quantative data regarding policy toxicity which they will take into consideration when writing their recommendations for improvement.
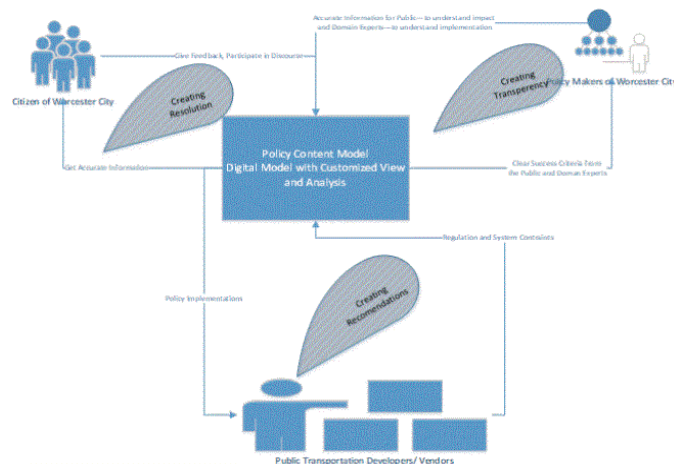

Diagram modeling Professor Bhada's research plan for applying the policy content model.

Professor Laureen Elgert

What is the Rights of Nature concept and how do the rights of our planet fit into human society? Simply put, Rights of Nature involves just what it sounds like; honoring that nature has rights. That our ecosystems and the animals, plants, oceans deserts, mountains, etc. have rights just as humans do. Professor Laureen Elgert has studied this idea thoroughly, examining court cases involving Rights of Nature in Ecuador and how the subject controls how humans can use nature. With her background, Elgert researches how Rights of Nature will affect local human rights and control over their productive resources to regulate their own livelihood. Currently, public support for environmental quality is high, yet despite high public approval issues may arise for people dependent on the land to live.

For example, Elgert cites the average farmer who wants to buy a parcel of land for agriculture may have difficulty doing so with laws in place regarding Rights of Nature enforcing that the area needs to remain conservation land. This is why Elgert dutifully researched Rights of Nature; to understand that imposing Rights of Nature would change the control people have over how they use local resources and the social justice issues that may arise and what can be done. Elgert passes her knowledge of Rights of Nature along to IQP and MQP students bound for WPI's Latin America project site so they may complete their project work, regardless of their topic, with nature's rights in mind.
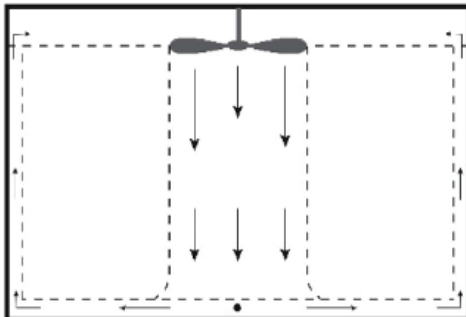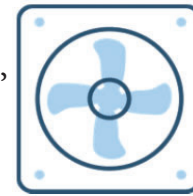
Image taken by Professor Elgert of a banner protesting the council in Latin America.

Professor Shichao Liu

Professor Liu, who is part of WPI's civil and environmental engineering department, currently does research centered on building science. There are two dimensions of his research on building science; building energy simulation estimation and building designs that increase energy efficiency while maintaining the occupant's thermal comfort. Since building energy consists of 40% of our energy usage in the United States, it is important to find solutions that allow the energy to be used efficiently for nationwide sustainability.

Construction of more energy-efficient buildings affects environmental quality through the person's thermal comfort. For example, if you feel hot in a space, you turn on the air conditioning. If you feel cold, you turn on the heat. This is how one maintains thermal comfort in a building. But, as Liu notes, the ventilation systems are designed to condition the entire space. Yet, people may only be using certain locations within the space. For most of the time, the employee in their office may only need the space around their desk in the corner thermally conditioned. This finding is important for Liu to reach his research goal; to maintain people's thermal comfort with minimum energy usage. People have the option to use a fan to increase air movement around your body for some cooling effect. Since fans cost much less than air conditioning and cool you where you'd like, they are a much more cost and energy efficient option to air conditioning.

Conceptual model of air flow from a ceiling fan found in *Experimental and numerical investigations of indoor air movement distribution with an office ceiling fan.*

Looking at building climate control through the current COVID-19 situation, many buildings are using their ventilation ducts to increase air flow. These ducts are on the ceiling, which is not the most effective location considering that viruses come from people's nose and mouth. Liu also researches more cost-effective solutions that put air towards the person's respiratory system, as well as creating a system that purifies the air while running.

Professor
Sarah Eliza Stanlick

Lately, Professor Stanlick's research involves public interest technology, which she thinks as a tool to address some of the UN Sustainable Development Goals. She recently co-edited and authored a book with Dr. Whitney Szmodis of Lehigh University titled "Beyond the Classroom: Perspectives on Lifelong Learning and Global Citizenship". Contributors covered topics from indigenous knowledge and health in Australia to community gardens and food security in Hawaii. The volume, focused on SDG #4: Quality Education, connects to global citizenship as well as identity development in students and communities alike, which is one of Stanlick's research focus. As part of her research, Stanlick studies these students and their communities to see if they feel that they commit to and/or catalyze positive change regarding the SDGs.

On the technology side, her research focuses on how technology can aid vulnerable groups of people and be utilized for public good. For example, one of her projects focuses on grandfamilies. The subject area involves grandparents that for a variety of reasons end up caring for their children and/or grandchildren. Stanlick researches ways to preserve the health and wellbeing of these grandparents through online learning communities. She feels that quality education should be available to all groups, which is why her research also involves creating open educational resources and educational access points. Though not directly related to the environment, Stanlick's research does relate to sustainability through health, education, and social support. Her research and how it links to sustainability also serves as an important reminder that sustainability involves the wellbeing of the land, human interaction with the land, and people themselves.
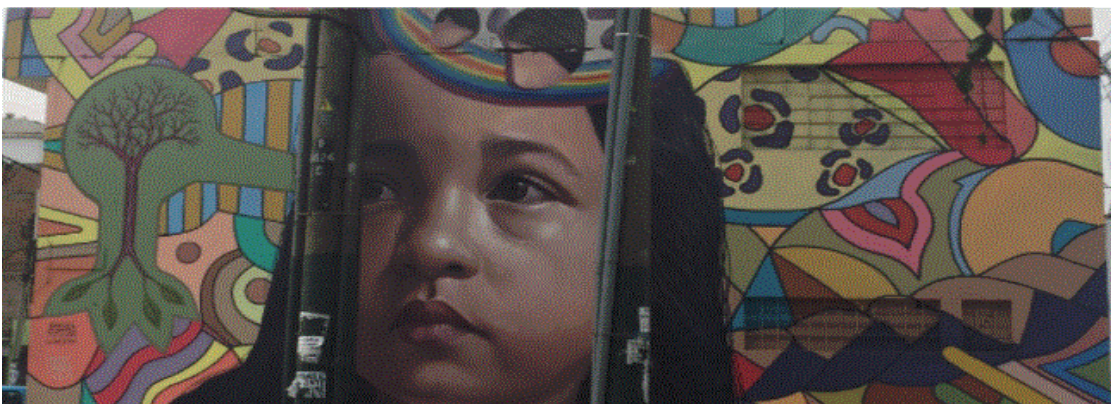
Painting on city walls from the Women's Human Rights teaching, learning, and advocacy resource.

OPERATIONS & FACILITIES

WPI completes annual assessments of its yearly consumption of water, electricity, gas, and greenhouse gas emissions. From the data WPI collects from its operations and facilities departments, the sustainability office organizes and accesses the information. Transportation, dining services, recycling, and notable sustainable features around campus are also reviewed. The data from these analyses are summarized in this section.
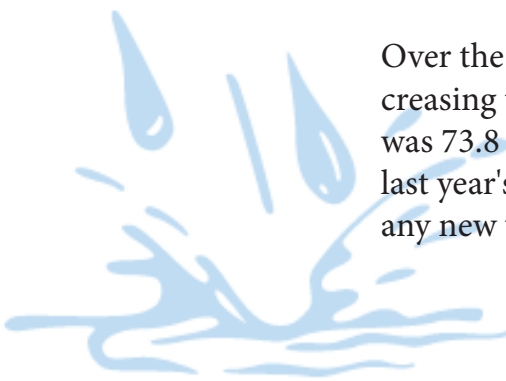
Water

Essential to life on and beyond WPI, water is required for animals and plants. People also use water for a variety of other processes, including cooking, cleaning, agriculture, and industrial processes. WPI's water use is categorized by general water consumption and discharges to the sewe system, lumped together into total water consumption for data analysis purposes. With all its necessities, water must be conserved. To help reduce its consumption, WPI uses low-flow shower heads in residence halls. These shower heads spray water at the low rate of 1.75 gallons per minute. Below are two graphs, the first showing yearly water consumption at WPI campus wide and the second visually representing monthly water use this year.

Yearly Millions of Gallons of Water Consumed
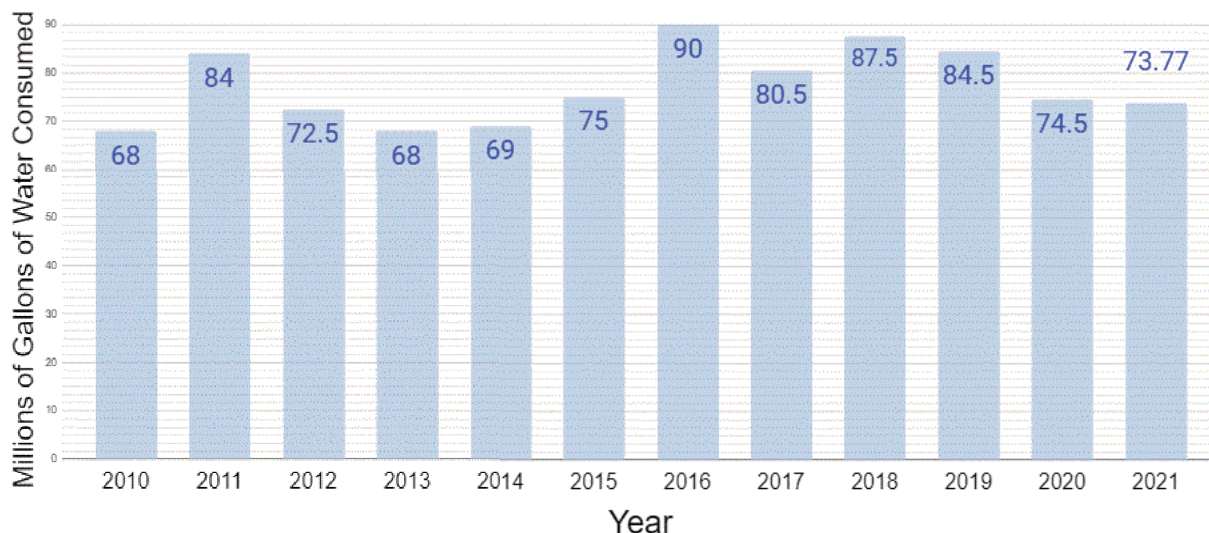
Over the past three years, WPI's water use has followed a decreasing trend. However, for this year, the water consumption was 73.8 million gallons per year, which is slightly lower than last year's value. This amount is reasonable since there weren't any new water conservation projects completed this year.
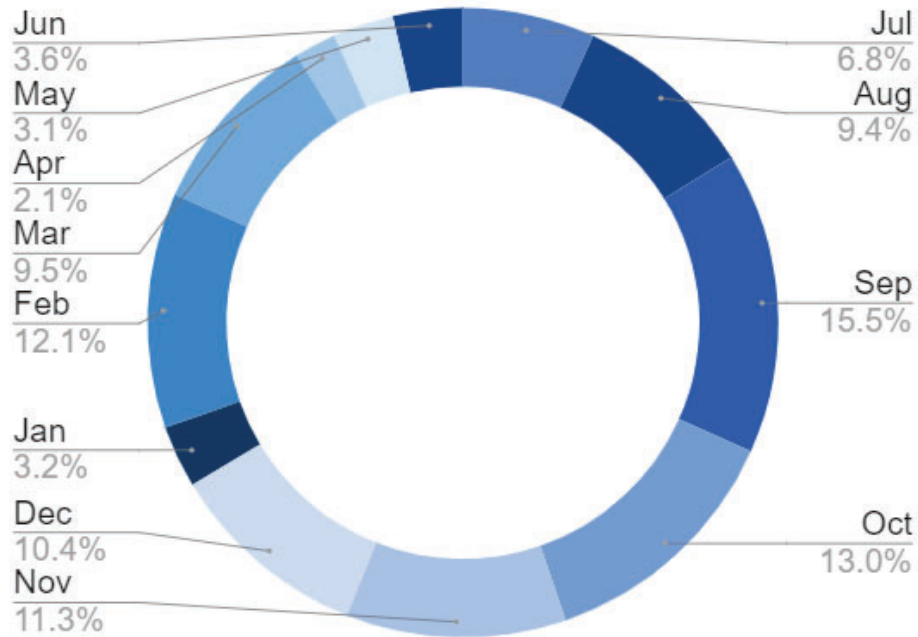
73.8
million gallons
of water used
this year

50.2%
of all water
used during
A and B term
(Sep-Dec)

Consumption Percentage vs. Month

Jun
3.6%
May
3.1%
Apr
2.1%
Mar
9.5%
Feb
12.1%

Jan
3.2%
Dec
10.4%
Nov
11.3%

Jul
6.8%
Aug
9.4%

Sep
15.5%

Oct
13.0%

As for last year's water consumption, this year's months of highest consumption include September and October. The summer months exhibit the lowest water consumption rates. The increase in students, faculty, and staff on campus for the start of the academic year likely explains this trend. Previous IQPs have addressed WPI's water use and some of these changes will be considered in the future.
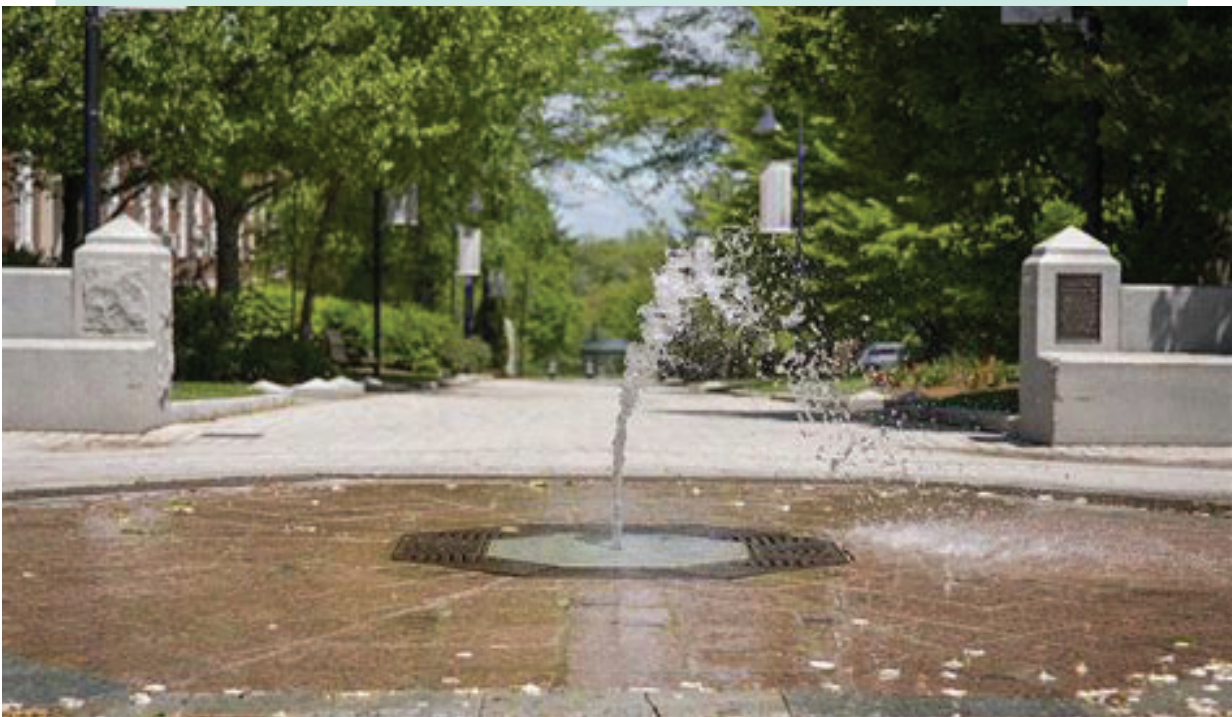
Electricity

Electricity plays a major role in the WPI community and beyond. The potential uses seem to go on forever from powering our computers, lamps, sinks, vacuums, spectrometers, and so on. Unfortunately, the providor of our electricity is from burning non-renewable sources which leads to green house gas emission. To reduce our carbon footprint, WPI updates our campus buildings with energy-saving technology such as motion sensors and LED lighting.
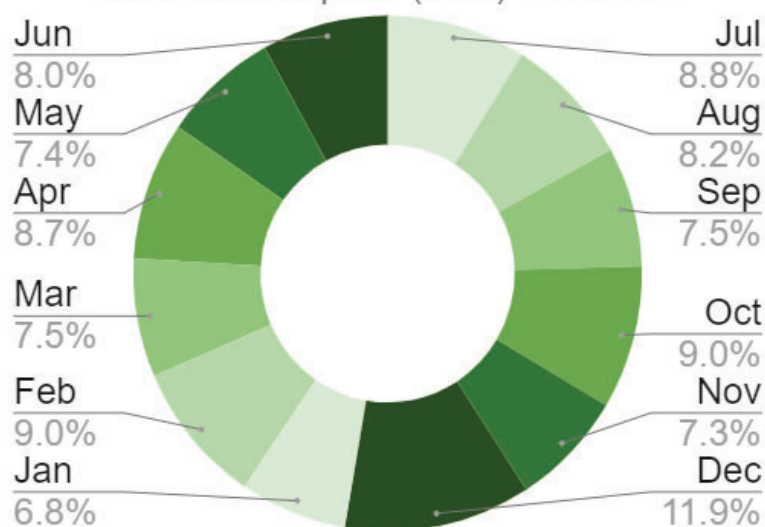
Total Electricity Consumption
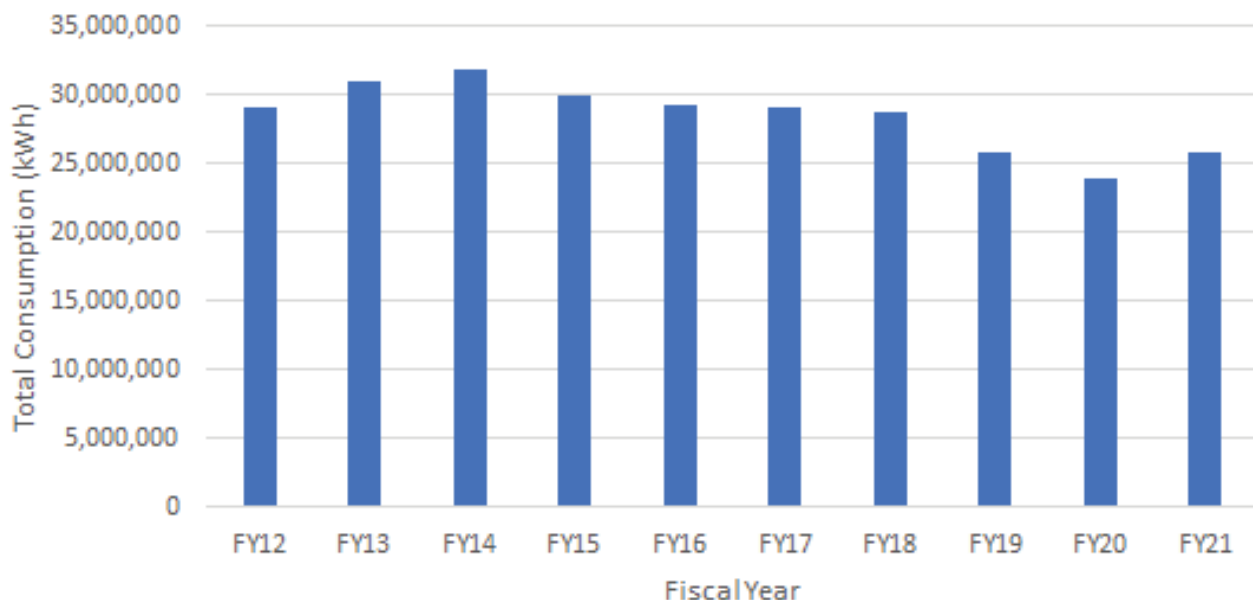
Despite the downward trend in the last few years, WPI's electricity usage increased slightly this year. The increase could be due to a variety of factors, such as the status of GRF projects, new uses, or even changes in weather conditions. Monthly electricity uses remained relatively constant throughout the year, with no extreme highs or lows. Increasing awareness could help to further reduce electricity use.

20% of total power from wind and solar sources.

25.2 million killowatt hours of electricity used this year

Total Consumption (kWh) vs. Month

Jun 8.0%
May 7.4%
Apr 8.7%
Mar 7.5%
Feb 9.0%
Jan 6.8%
Jul 8.8%
Aug 8.2%
Sep 7.5%
Oct 9.0%
Nov 7.3%
Dec 11.9%

Natural Gas

Natural gas, a common alternative to fuels like oil, is an energy source emitting mostly only carbon dioxide and water when burned. As opposed to oil and coal which produces sulfur, nitrogen, ash particles, and other particles. For eighteen years, WPI has been using natural gas to heat campus buildings rather than oil., bringing WPI closer to our goal to have 20% less emissions by 2025.
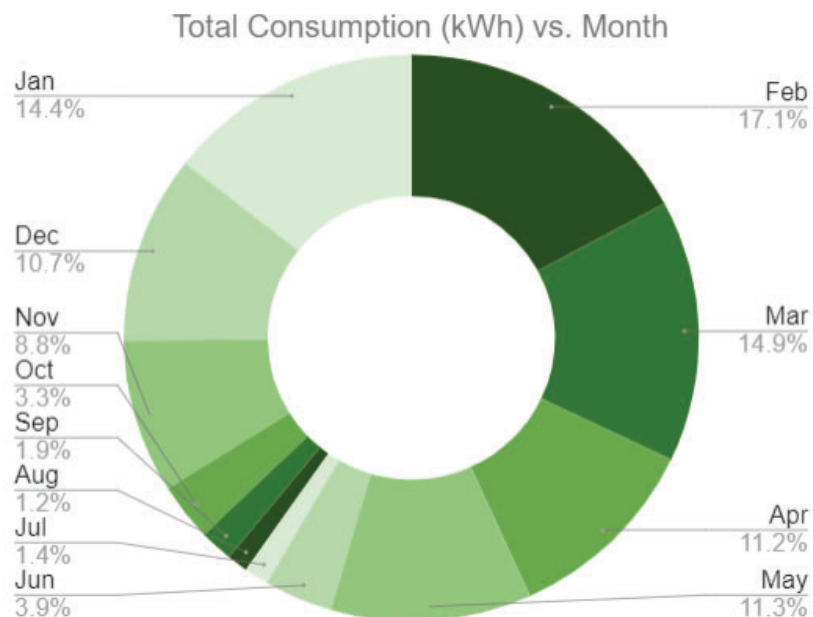

Natural Gas Consumption
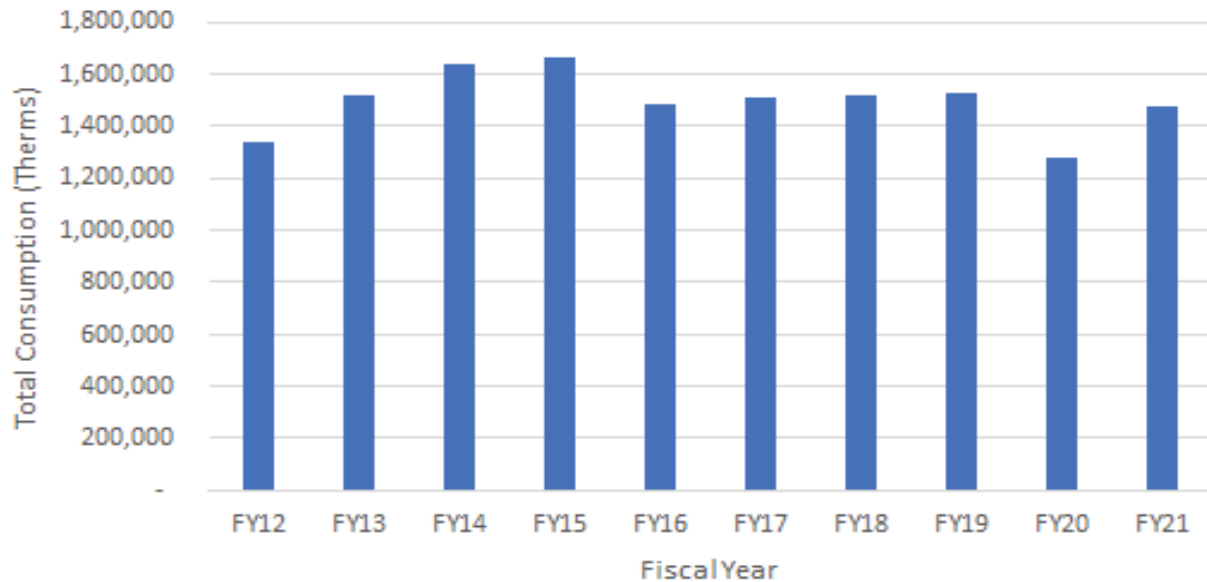
This year, total natural gas consumption increased significantly from last year by a little less than 200,000 therms, yet is still the third lowest this decade. It is possible that changing temperatures or students on campus play a role in total consumption. In terms of monthly consumption of natural gas, usage seems to follow a seasonal trend with the majority consumed during colder months. This is likely due to heating buildings.

57%
of total consumption during winter (Dec-Mar)

1.48
million therms of natural gas consumed this year

Total Consumption (kWh) vs. Month

Jan 14.4%
Feb 17.1%
Mar 14.9%
Apr 11.2%
May 11.3%
Jun 3.9%
Jul 1.4%
Aug 1.2%
Sep 1.9%
Oct 3.3%
Nov 8.8%
Dec 10.7%

Emissions

Emissions account for more than simply the campus vehicles. WPI considers emissions from a variety of other energy sources including electricity emissions, refrigerant emissions, and vehicle emissions. These are released gas particles that remain in the Earth's atmosphere as greenhouse gases, raising Earth's temperature. Below please find charts of WPI's monthly and yearly emissions for this year and emissions dating back to 2010.

Total Emissions (Metric Tons) vs. Year
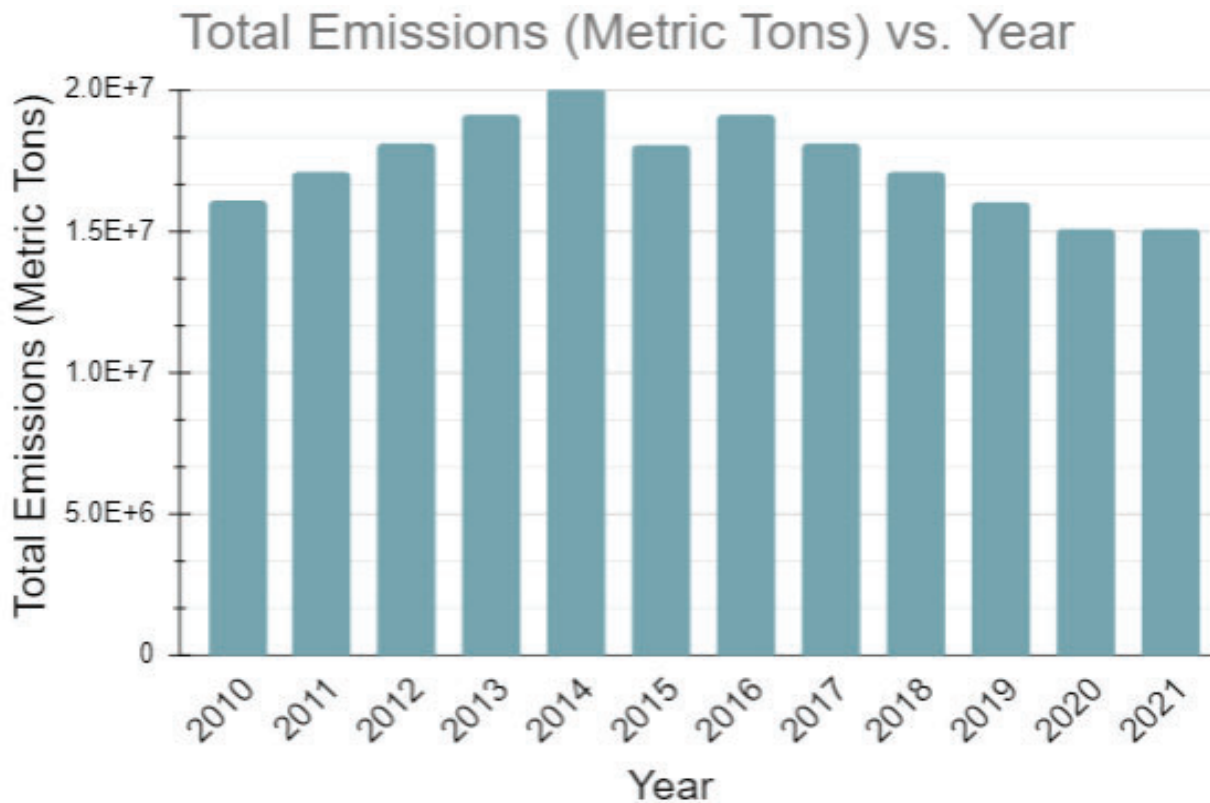
Despite new sustainable efforts from student projects and from the GRF, total emissions this year is not as low as predicted by the trend of the graph. This could be due to more available data on smaller emission sources, such as refrigerants, becoming available this year. Similar emission in comparison to last year could also be due to the fact that no new GRF projects to reduce campus emissions occured this year. Even though there were no new projects, WPI continues to see emission reduction due to past projects and has the lowest emissions to date since data collection began. With the continually decreasing trend, WPI stays on track to meet its carbon dioxide emission reduction goals by 2025.
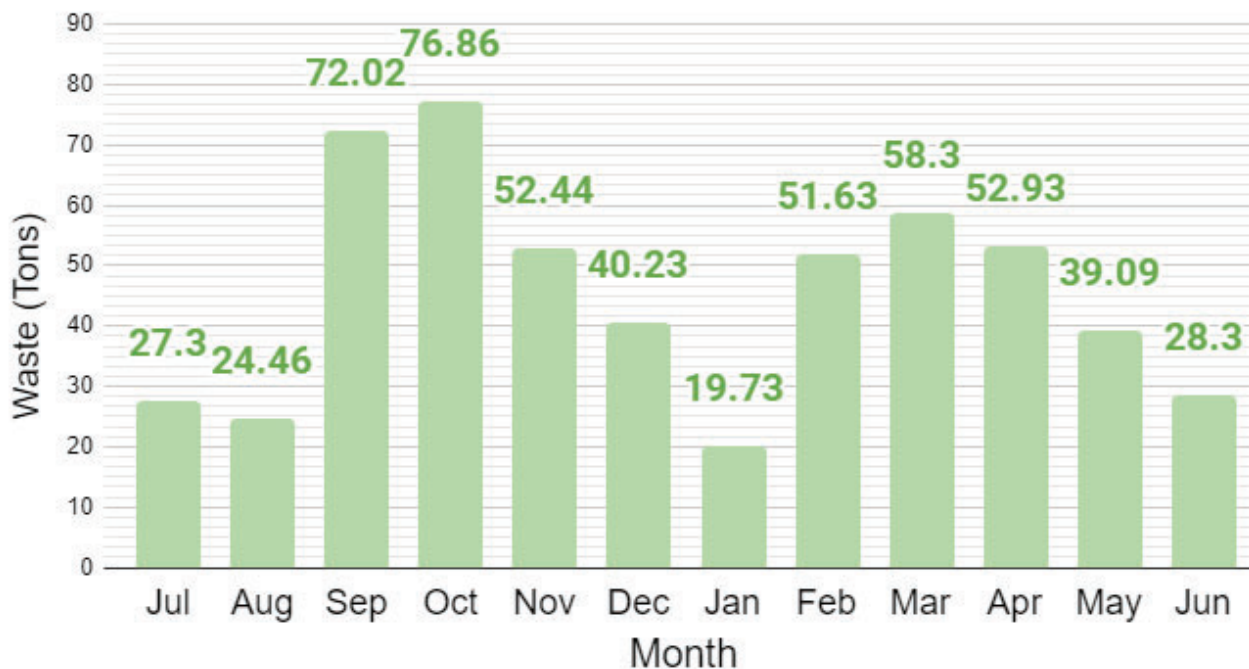
about

5

million metric tons less emissions than last year

about

15

million metric tons of total emissions this year

Waste & Recycling

At WPI, recyclables are considered clean plastic, paper, cardboard, glass, and aluminum products which can be transformed into usable products. Bins for recycling as well as waste are stationed in campus buildings by the green team, while the facilities department handles the waste and recyclables themselves. In total this year, WPI created 543.29 tons of waste. Of this waste, the monthly consumption values increase and decrease dramatically each month, following a trend with WPI's terms when students are on campus

Waste (Tons) vs. Month

Despite waste consumed varying greatly by month, total waste tonnage does not change greatly each year. Lately, WPI consumes around 550 tons of waste, with about a quarter of that waste recycled.
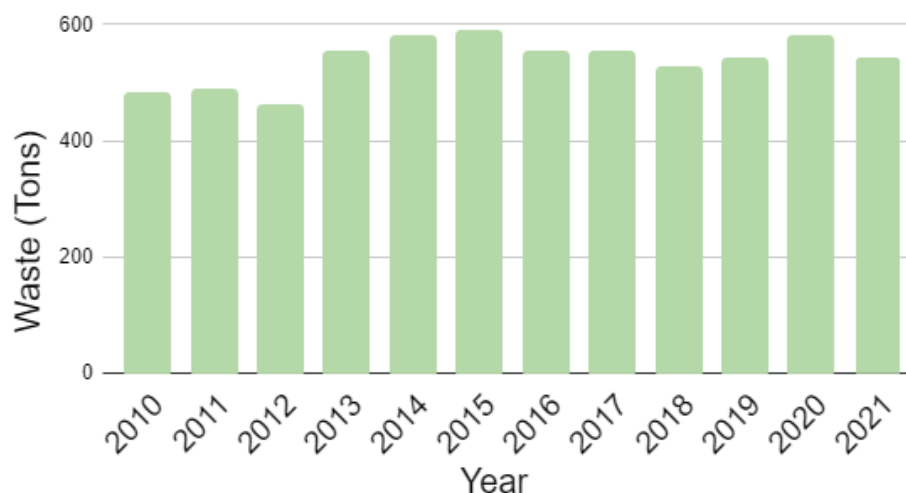
543
total tons of waste consumed this year (jul-jun 2020-2021)

about
34
tons less than last year

Waste (Tons) vs. Year

GRF

The Green Revolving Fund (GRF) is a fund that provides a budget for sustainable projects and renovations on WPI campus. Cost savings from sustainable upgrades and additions are rolled back into the fund, allowing for additional cost-saving sustainability projects. For example, the installation of low-flow shower heads and LEED lighting in the residence halls reduced WPI's electricity expenditure. The GRF supports sustainability projects that will generate financial returns, reduce environmental impact, or carbon emissions, enhance the academic climate, and engage the WPI community.

The fund was seeded with $500,000 in allocated for use towards sustainability renovations on campus.

This year, the fund received slightly more than $200000 in savings from previous year's projects.

For example, fanances from the fund were used for retro commissoning of Harrington Auditorium. The old equipment in that building was replaced with new, efficient devices.

Based on the calculated heating, cooling, water consumption, and other equipment efficiency improvements, WPI plans to recoup the funds put towards this project in a little over 2 years.

Although the pandemic resulted in a delay of some of our initaitives, WPI will continue to develop sustainability initiatives to reduce our resource use and advance sustainability through the Green Revolving Fund

Transportation

As a city-centered campus, transportation options and ammendities are plentiful. Besides the variety of travel options WPI offers free to students and staff, Worcester offers its own public travel options including busing and cab drivers around the city as well as trains out of the city to Boston.

Gompei's Gears Bike Share Program

Starting as an IQP in 2015, the bike share continues to be an integral and economical transportation method for WPI's students. WPI students and faculty alike are able to use the program for free. This year one station in-front of Salisbury Labs remained open for use throughout the entire year. Since its founding, the Green Team holds the essential responsibility of bike maintenance. As the bikes part of the share get older, the Green Team continues to work diligently to keep the bikes in safe for riders.

6 Years

4 Stations

24 Bikes

Over **1000** Users

Looking ahead, Gompei's Gears hopes to upgrade its locking system to bluetooth as well as reopen the Quad's bike station. In the coming spring, the bike share maintenance team hopes to hold table sittings near the bike stations for students to learn about how to reserve a bike.

Scooter

Zipcars

Not only are WPI's zipcars aconveniently located at Park Avenue Garage and inexpensive, they are also far more economical because the cars are electric and hybrid. This allows students, faculty, and alumni to easily reduce their carbon footprint.

Walking

Public Transport

SNAP

WPI's Student Night Assistance Patrol passenger vans for use by students at night. Riders simply show their WPI ID and buckle up.

Due to the pandemic, certain seats in the vans were blocked off to promote social distancing. Passengers were also required to wear a face covering and use hand sanitizer before boarding.

Ride Sharing

In hopes of reducing the number of single occupancy vehicles (SOVs) on the road, WPI encourages ride sharing and carpooling to and from campus.

Shuttles

Transport for students to Price Chopper, Gateway Garage, and the South Village area. There are also stops for students housing around campus.

Due to the pandemic, the Price Chopper shuttle added a stop for students residing in the Hampton Inn.

Biking

Electric Vehicles

WPI is glad to provide free electric vehicle charging stations at Park Avenue Garage.

Dining Services

Due to the pandemic, the dining experience at WPI underwent a major shift. The old walk-in style was replaced with a reservation system to spread crowds out during lunch and dinner time rushes. Silverware and dishes at Pulse on Dining (POD) and the Goat's Head Restaurant were replaced with disposible paper to-go containers. Further helping with crowd dispersal, the campus center food court was added to WPI's dining plan, encouraging the many students, especially on-campus freshman, to seek alternate locations for meals. Gordon Library's cafe was put on heiatus for the duration of the pandemic, and new robotic, salad-making machines and a smoothie lab were added to better accomedate students seeking a simpler, healthier diet.

Dining Services

Provided by Chartwells
Paper and plastic recycled
WPI's student club the Food Recovery Network brings unserved food from the buffet to local Worcester homeless shelters. Food scraps are given to a local pig farmer.
Meal Options and Food:
Vegetarian, vegan, and gluten-free
Cage-free eggs
Local ingredients utilized where possible
Fair-trade coffee and tomatoes
rGHB free yogurt and milk
Seafood from sustainable sources
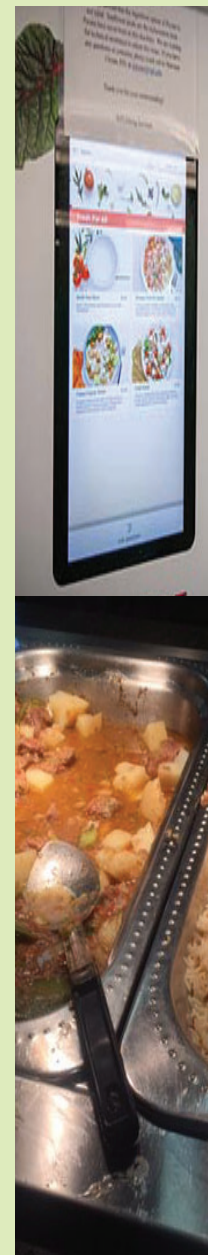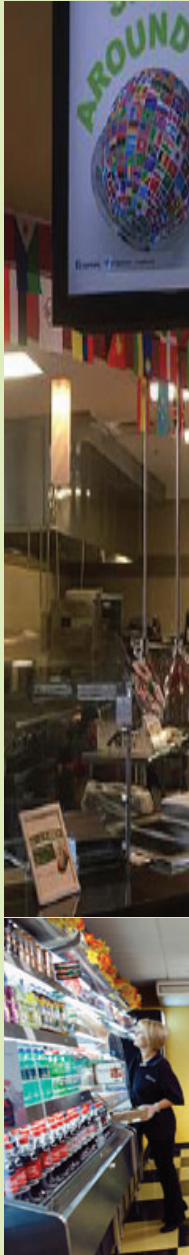Reduced antibiotic turkey and chicken

Morgan Dining Hall POD

Variety of ethnic food options from the Spoon

Campus Center Food Court

Uses Earth-friendly dining vessels

Goat's Head Restaurant

Newly-renovated

Campus Buildings

It is important for WPI to set an example for others by continuously renovating and constructing towards a more sustainable campus environment. As the WPI community grows, improvemnets to current buildings as well as more sustainable learning spaces are necessary.

LEED-Certified

LEED stands for Leadership in Energy and Environmental Design and it is a well-recognized rating system for green buildings. Currently, WPI has five LEED-certified buildings: the Recreation Center, Bartlett Center, East Hall, Faraday Hall, the Innovation Studio & Messenger Hall. The Recreation Center, East Hall, and Innovation Studio have gold LEED certification, Faraday Hall has silver LEED certification, and the Bartlett Center is LEED-certified. Notable aspects include a green roof on East Hall, solar heating for the Recreation Center's swimming pool, energy-efficient LED lighting in East Hall and Faraday Hall, as well as water bottle refill stations in most buildings.

Construction & Renovations

Over the sumemr of 2021, Kaven Hall, which is WPI's Civil and Environmental Engineering department location, is undergoing renovations. Kaven Hall is receiving a new heating and ventilation system. The replacement will increase the building's energy efficiency.

Construction continues on the new academic and office building behind Gordon Library. The building will be LEED-certified. Currently, the building is LEED silver but there is still hope to find a new way to obtain gold certification after WPI was unable to get new zipcars for the building. Notably, a new solar array will go on the building. Both students and staff axiously await its completion!
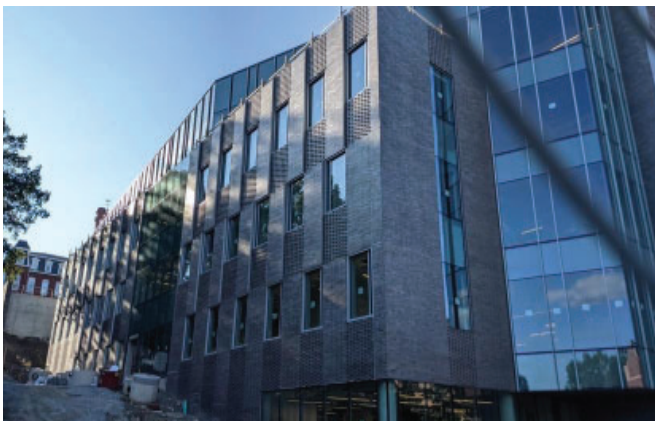
COMMUNITY ENGAGEMENT

The entire WPI community, including but not limited to our students, faculty, and alumni, play a role in sustainability. By supporting WPI, we support our sustainable clubs, organizations, and events. Despite the pandemic, the WPI community found ways to connect on campus, locally, and globally for sustainable activities.

Clubs & Organizations

Currently there are 235 student groups. Of these groups, over 10 of them are stustainability-related. Some clubs and organizations affiliated with sustainability are listed below.

American Society of Civil Engineers (ASCE)

This organization assembles WPI's civil engineering students and provides them with programs and events meant to prepare them for the industry.

Events: ASCE Steel Bridge Competition, Concrete Canoe Competition, General Body Meetings

Outing Club

This club encourages more outdoor activity through organized group trips and expeditions.

Events: Rock Climbing, Hicking, and tons of outdoor activities., General Body Meetings

American Academy of Environmental Engineers and Scientists

This organization creates and advertises opportunities for interested WPI students in Environmental actions.

Events: Guest Speaker Presentations, Courses, General Body Meetings

Greenhouse and Horticulture Club

This club focuses on maintaining the plants living in WPI's Salisbury Greenhouse.

Events: Plant Parenthood, General Body Meetings

Engineers Without Borders

This organization aims to create a better world for all by providing engineering projects that empower communities and help people meet their basic needs while solving global challenges.

Events: Current Project: FIRST FLUSH WATER FILTRATION IN ECUADOR

Green Team

This organization helps to improve WPI's sustainability through educational on-campus events.

Events: Green Talks, Project Clean Plate, Sustainability Pledge, Waste Audit, Lighting Fair, Recyclemania, Earth Fest, E-Waste Drive, Trivia Nights, Plant and Paint, General Body Meetings

Vegetarian Club

This club supports members of the WPI community that are currently living or seeking the vegetarian or vegan lifestyle while promoting vegetarian and veganism on campus.

Events: Group chats, Cooking Events, Vegan Confessions

Food Recovery Network

This organization collects unserved food from POD and brings it to homeless shelters in Worcester.

Events: Trips to local shelters

Habitat for Humanity

This organization allows WPI's student volunteers to assist in the fundraising and building homes to benefit those living in slum housing and the homeless.

Events: Habitat Relay, Local Building Project, Act, Speak, Build Week

Students for a Just and Stable Future (SJSF)

This regional student organization focuses on social justice as well as respecting the environment. The group battles leaders in climate change as well as social injustice by enacting laws.

Events: Group chats, notifications for local events

Campus Race to Zero Waste

Campus Race to Zero Waste started as Recyclemania before it was renamed this year. Each year since 2008, WPI enters in the competition along with other colleges and universities nationwide. The goal is to see who can recycle the most cardboard, plastic, and paper while producing the least waste. This year, the green team hosted Green Talks, a seminar on waste, and produced a video learning course about recycling.

Sustainability
environment · economy · social justice
on campus, in our community, and around the world **WORCESTER POLYTECHNIC INSTITUTE**

Recycling and Waste Management in a time of transition

- Waste and Recycling in aftermath of the COVID-19 pandemic and global recycling market disruptions
- Circular Economy: how recyclables are used to make new products
- Materials and assessing GHG emissions impacts vs. reuse
- Social Justice: environmentally friendly, sustainable solutions & affordability

Michelle Lee Guiney serves as Manager of Waste Management's Total Recycle Program. She has over 10 years of experience in the waste industry, is Zero Waste certified, and LEED accredited.

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**innovatingreen**

WM WASTE MANAGEMENT

Flyer publicizing the Campus Race to Zero Waste event; "Recycling and Waste Management in a time of transition".

The Green Team's focus was to spread information and awareness with regards to recycling and waste management. Topics of the "Recycling and Waste Management in a time of transition" seminar include Waste and Recycling in aftermath of the COVID 19 pandemic and global recycling market disruptions, Circular Economy: how recyclables are used to make new products, Materials and assessing GHG emissions impacts vs. reuse, and Social Justice: environmentally friendly, sustainable solutions & affordability. Though the live presentation occurred on March 29th, others can still view the recording online.

25 students attended the live seminar led by Michelle Lee Guiney of Waste Management in cooperation in cooperation with WPI's Office of Sustainability and the Green Team.

Living and Learning Laboratory

WPI's Sustainability Laboratory for Living and Learning (SL3) was initiated this year to support the our Sustainability Ecosystem, which is outlined in our sustainability plan. This is a virtual laboratory that supports and promotes an engaged campus community in all three aspects of sustainability – environmental stewardship, economic security, and social justice. The laboratory will be coordinated through the Office of Sustainability, with efforts that integrate our academic programs, projects, research and scholarship with facilities, operations, and community engagement (local, regional and global). This was included in a web site intended to guide WPI students, faculty and other community members to the resources and activities associated with the Sustainability Living and Learning Lab (SL3).
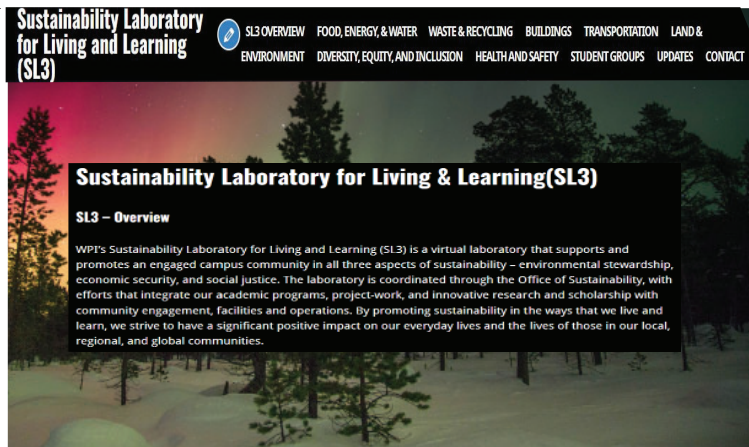
SDG Initiatives @ WPI

The United Nations Sustainable Development Goals (SDGs) represent a global commitment to improving the welfare of all people, by advancing 17 goals to achieve by 2030. At WPI our goal is to improve human life through technology, recognizing that our choices impact the well-being of others. This goal aligns with the SDG's and incorporates all aspects of sustainability and our sustainable incluse excellence initiatives as well. On April 22, 2021 (Earth Day), we held a discussion on how WPI, through our academic programs, projects, and research, inches the university closer to materializing these goals for a brighter future for everyone. The program included an introductory presentation by the Provost Soboyejo, presentations by faculty, staff and a student project team, and a a faculty conversation, Other on-going initiatives an efffort by the Office of Sustainability to assess WPI's progress in relation to the SDGs, a working group to advance the SDGs at WPI, and a web site by Gordon Library to provide a guide for exporing the SDGs.

CONCLUSION

The sustainable activities and actions underway at WPI t.his year go beyond what we can include in the report. We appreciate the efforts of our community to drive WPI towards a continual decline in resource and waste consumption - from fewer gallons of water and watts of electricity, to more community talks and gatherings encouraging the campus to think greener. The pursuit toward a sustainable future is challenging, but WPI's endless projects, clubs, research, and events provide many opportunities to improve campus awareness and having an impact beyond our campus as well. We look forward to continuing this pursuit.

Environment — Social

Sustainability

Economic

ACKNOWLEDGEMENTS

"I would like to thank Diane Begreen for her help organizing IQPs, Saranya Mira Plante and Rushab Patil for their assistance with Gompei Gears bike share maintenance, Kayla Everett for answering my questions with Adobe InDesign, and Douglas Koethe for his work organizing data for the GRF and with WPI's facilities department. Thank you to WPI's faculty researchers for sharing your unique work this year regarding sustainability. This report could not have been done without help from WPI's facilities department for communicating our resource data, so thank you! Finally, a special thanks to associate professor of the Civil and Environmental Engineering department as well as the Sustainability Director Paul Mathisen.

We are a community that thrives off continual involvement from our students, faculty, alumni, and staff. Thank each of you for playing a role in our community!"

<div align="right">

Shannon Henderson
Environmental Engineering Major
Class of 2023

</div>

Last but not least, thank you reader for learning about how WPI
is becoming more sustainable!

Want to learn more? Please visit
    WPI's Office of Sustainability webpage: https://www.wpi.edu/offices/sustainability
    WPI's Sustainability Living and Learning Laboratory (SL3) webpage: https://wp.wpi.edu/sl3/
Or email WPI's Green Team at green@wpi.edu

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"THE 17 GOALS | Sustainable Development." United Nations, United Nations, sdgs.un.org/goals.
Wenhua Chen, Shichao Liu, Yunfei Gao, Hui Zhang, Edward Arens, Lei Zhao, Junjie Liu, Experimental and numerical investigations of indoor air movement distribution with an office ceiling fan, Building and Environment, Volume 130, 2018, Pages 14-26, ISSN 0360-1323, https://doi.org/10.1016/j.buildenv.2017.12.016.

Endnotes

WPI 2021

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WPI