engineering FOR CHANGE

2024 E4C Impact Project Report

By Engineers, for Everyone

We are a Bridge between Engineering & Sustainable Development

We Prepare, Educate, and Activate the International Technical Workforce for the Benefit of People and the Planet

A Year's Overview

Impact Projects

Engineering for Change (E4C) is a non-profit organization dedicated to preparing, educating, and activating the international technical workforce to improve the quality of life of people and the planet. We cultivate change agents by providing resources, platforms, and access to expertise to accelerate the development of solutions and infuse engineering into sustainable development.

E4C was founded jointly by the American Society of Mechanical Engineers (ASME) and other leading engineering societies.

E4C Impact Projects advance the sustainability objectives of impact-driven organizations by sourcing exceptional talent through our Fellowship Program to address critical design needs and research questions to advance the UN's Sustainable Development Goals. Impact Projects fall into one of our three key streams: Design for Good, Impact Research, and Advancing Workflows.

E4C 2024 Program Management Team, Impact Projects:
Jonathan Kemp, Program Specialist
Erin Peiffer, Program Coordinator
Elizabeth Collins, Program Associate
Tanvir Khorajiya, Junior Program Associate

Published May 2025

AUTODESK FOUNDATION

In 2024, E4C welcomed 46 Fellows from all over the globe. This year, the Autodesk Foundation collaborated with E4C to support 33 of these Fellows, matching them with practical design and research projects from the Autodesk Foundation's portfolio of nonprofits and startups. These savvy early-career designers and engineers from all over the world drew on their experience and expertise in Autodesk technology to provide tangible impact for their partner organizations. Projects included development or improvement of products, advancement of workflows in organizational design and Autodesk technology, and targeted research.

In 2025, the Autodesk Foundation and E4C are collaborating again to provide portfolio organizations the opportunity to receive targeted technical support while simultaneously growing the human infrastructure and local capacity of the next generations of technical professionals.

Read full reports at:
www.engineeringforchange.org/research

Read more about our Fellowship and Research Fellows:
www.engineeringforchange.org/fellowship

Find out about becoming a research partner:
www.engineeringforchange.org/impact-projects

2024 Impact Projects Partners

Our 2024 Fellow Team Leads

Managing Fellows & Technical Lead Fellows

Alex Inoma
Nigeria
Managing Fellow

Arianna Andino
Ecuador
Managing Fellow

Isaac Njoroge
Kenya
Managing Fellow

Joan Nalianya
Kenya
Managing Fellow

Mufaro Kanganga
Zimbabwe
Managing Fellow

Ogechi Ogbonna
Nigeria
Managing Fellow

Sandra Sinzi Ineza
Rwanda
Managing Fellow

Sydney Okoroafor
Nigeria
Managing Fellow

Chinemerem Iheanacho
Nigeria
Technical Lead Fellow

Symon Kiplelgo Kipkemei
Kenya
Technical Lead Fellow

Overall Statistics Dashboard

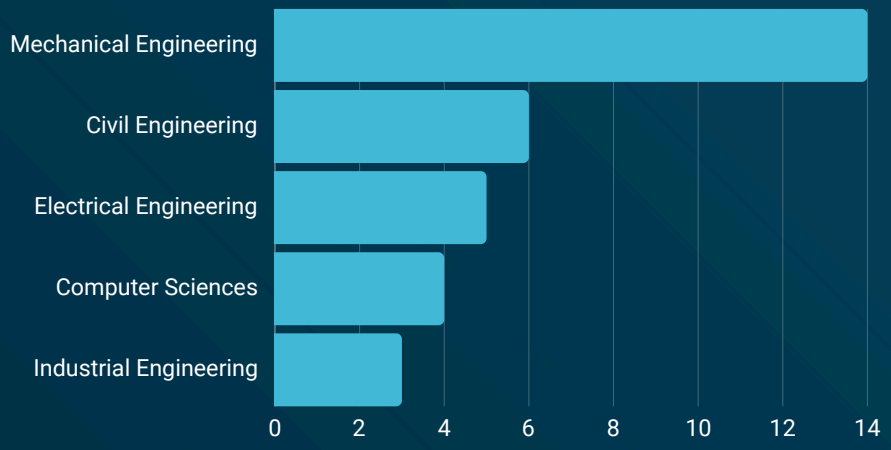
46
Fellows

26
Organizations

32
Impact Projects

17
Countries

Fellows' Most Common Areas of Study



Most Fellows have more than one area of study

74%

are between 25 - 34 years old

47.8%

Female Fellows

Countries Represented in the 2024 Cohort

17
Countries

Table of Contents

2024 Impact Projects

Table of Contents

2024 Impact Projects

Table of Contents

2024 Impact Projects

09 Industry, Innovation and Infrastructure

Table of Contents

2024 Impact Projects

Table of Contents

2024 Impact Projects

13 Climate Action

2 ZERO HUNGER

Research and Design of an Aerodynamic Grain Cleaner Machine

This project aimed to design and simulate an aerodynamic grain cleaner that, on fabrication and optimisation, will be used by rural farmers in India to produce market-ready and high-quality grains for the end users. The grain cleaner is expected to handle grains like corn, wheat, and pulses of varying sizes and moisture content. The project will increase profitability for the farmers, ease the strenuous conventional grain cleaning processes, and reduce the high cost of alternative grain cleaning processes currently in use.

The design started with market research to understand the end user needs, which was then translated to the design concept used as the basis for the design process. The design process included design analysis, calculations, drafting, and simulations. The machine consists of five main components: an axial fan, a hopper, adjustable shutters, a separation unit, and a machine frame for support.

The speed of the fan is controlled by a variable frequency drive. The separation unit consists of a louvre to direct the flow of air from the fan at a suitable and effective angle. The separation unit is also made up of several trays, which aid in the collection of the grains and impurities. The adjustable shutter, which is a hand-cranked control mechanism, helps to vary the width of the discharge trays, which, along with the variable speed of the fan, will help in multiple-grain cleaning.

The selected machine components were drafted using Autodesk Fusion 360 and Inventor. Comparative and feasibility studies on key parameters were conducted in Autodesk CFD, and the results were used to optimise the design further.

Key technology/tools used: Autodesk Inventor, Fusion 360, Autodesk CFD

3D model of the proposed aerodynamic grain cleaner.
Attribution: James Okwoche for S4S technologies

Project Partner:

S4S technologies
science for society

S4S Technologies was founded by a 7-member team with a common purpose to solve post-harvest problems faced by farmers and the food industry. Through a combination of technology and a unique model they are building a customer centric, sustainable & equitable agri-value chain.

Project Sponsor:

AUTODESK FOUNDATION

Partner Collaborators:

- Nidhi Pant, Co-Founder, S4S
- Vaibhav Tidke, Co-Founder, S4S

James Okwoche

Nigeria | **Mechanical Engineer**

Managing Fellow
Isaac Njoroge

Technical Lead Fellow
Chinemerem Iheanacho

James is a dedicated mechanical engineer, skilled in machine design, engineering simulations, 3D printing, and CAD. He is very keen on learning new things and collaborating, especially around sustainable development.

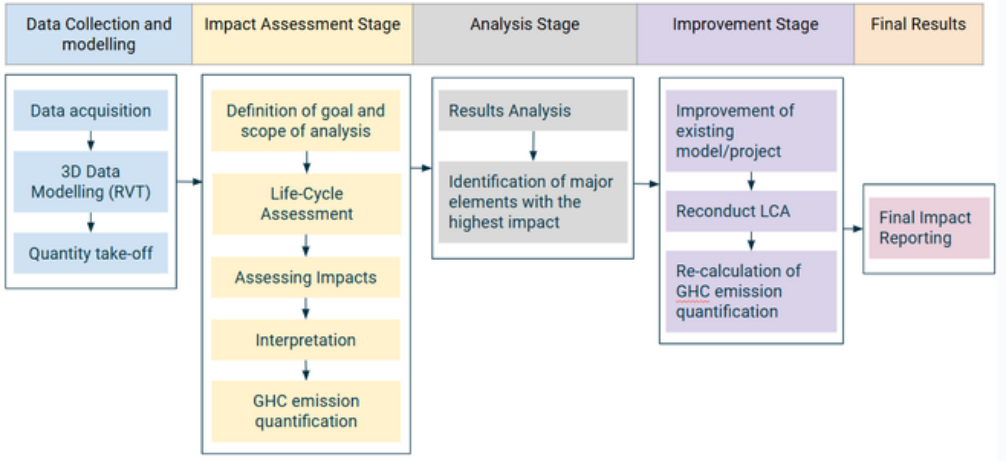
3 GOOD HEALTH AND WELL-BEING

BIM Sustainability Integration for Enhancing Global Health Infrastructure

This project was aimed at improving BHI's workflows by integrating architectural, engineering, and project management teams, with a specific focus on developing sustainability metrics within BIM management. The goal was to analyze BHI's existing processes, such as Autodesk Construction Cloud, Revit, and Insight, identify sustainability metrics embedded in BHI's Revit models, and propose recommendations for workflows to generate impact reporting analytics for both past and future projects of similar scope. A case study of two projects in Sierra Leone and Tanzania was conducted.

During this study, various environmental impact measurement tools, including OneClick LCA, Autodesk Insight, and Tally, were tested to determine which best align with BHI's current workflows. The information collected was used to generate appropriate sustainability KPIs and insights, develop model analysis workflows, and outline sustainability and impact reporting frameworks. This project will enable BHI to effectively track and document the environmental impact of its projects.

Key technology/tools used: Autodesk Construction Cloud, BIM 360, Insight, Revit, Tally, OneClick LCA



BHI's BIM Process for Project Impact Assessment. *Attribution: Alice Wachera*

Alice Wachera

Kenya | Civil Engineering

Managing Fellow
Ogechi Ogbonna

Technical Lead Fellow
Symon Kiplelgo Kipkemei

Alice is a detail-oriented Civil and Structural Engineer with 3 years of experience. She specializes in structural design, project management, and carbon emission studies and is proficient in Revit, AutoCAD, Civil3D, Robot, and BIM 360.

Project Partner:

Build Health International

Build Health International aims to improve healthcare access and infrastructure for marginalized populations in resource-constrained settings worldwide, ensuring dignity, affordability, and quality.

Partner Collaborators:

- Alejandro Ascuasiati, BIM Manager

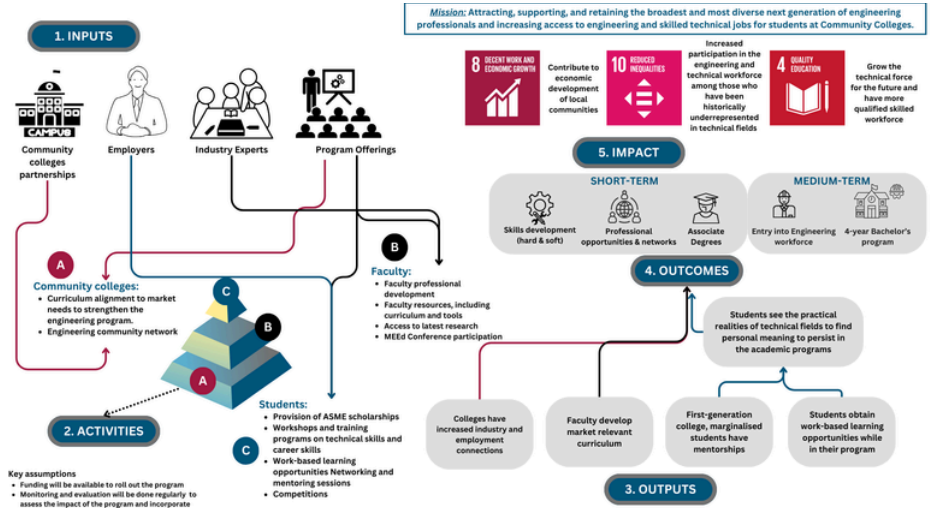
Project Sponsor:

AUTODESK FOUNDATION

ASME Community College Engineering Pathways Program

The Community College Engineering Pathway Program (CCEP) is an ASME workforce developmental program. Since May 2021, it has served engineering students in community colleges pursuing two-year degrees or other certifications. The program provides them with resources and opportunities for skills development to prepare them for the engineering and technical workforce.

The evaluation of the CCEP program on students' outcomes provided insights for scaling up the program, contributing to extending ASME's reach to over 80 community colleges and 1500 students in the US by 2026. Desk research was conducted to identify the best practices to assess post-graduation outcomes. An evaluation of the program was then conducted to gather data and assess the extent to which the program's intended outcomes have been achieved.



Theory of Change for the CCEP Program. *Attribution: Eunice Linah Tachie-Menson*

A comprehensive research report was presented, comprising of: the desk research outcomes; a plan and tools for measuring CCEP program outcomes; and key findings and recommendations on improving the program to better serve the needs of students in community colleges.

The key deliverables of this project were the design of an outcome evaluation process and a participant engagement tracker for routine monitoring of the CCEP program to enhance data-driven decision-making and inform program design and adjustment in subsequent years. Additionally, the impact research helped ASME understand the impact of its program on skills development, academic persistence, and post-graduation outcomes for its participants.

Key technology/tools used: Google Suite, Excel, Qualitative Research

Eunice Linah Tachie-Menson

Ghana | **Electrical and Electronics Engineering**

Managing Fellow
Mufaro Kanganga

Eunice is an educator passionate about integrating engineering for sustainable development into mathematics education to help future engineers see mathematics as a powerful tool to solve local and global challenges.

Project Partner & Sponsor:

ASME
SETTING THE STANDARD

ASME plays a key role in linking Academia, Industry, and Government. ASME Workforce Development focuses on fostering a diverse, equitable, and inclusive engineering workforce that addresses current and future employer needs, ultimately supporting economic growth and stability.

Partner Collaborators:

- Kathleen Kosmoski, Director of Workforce Development

Mechanical Engineering Research Landscape in India

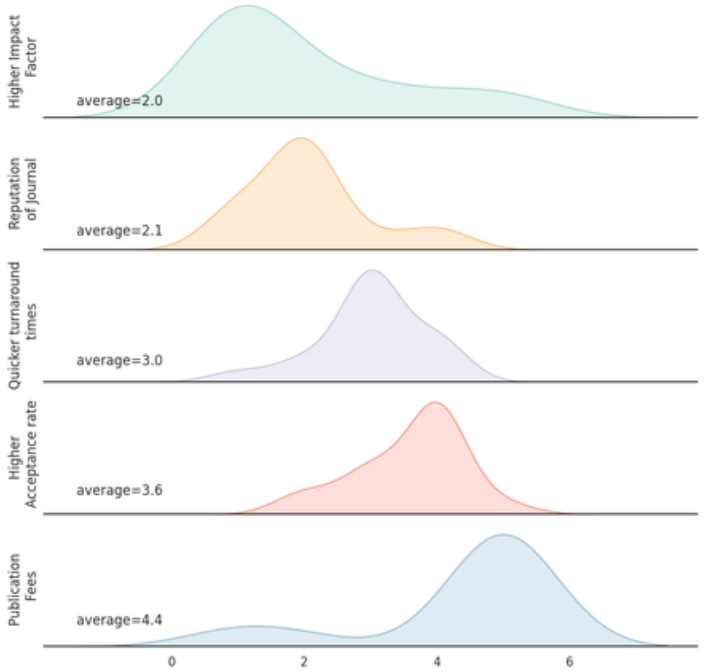
This project investigated the current state of Mechanical Engineering research in India, the challenges and barriers faced by Indian researchers, and how ASME can help improve the current scenario. The study aims to understand the challenges that limit the quality and quantity of research submissions from India and provides actionable recommendations to enhance ASME's engagement with Indian researchers and institutions.

The research methodology involved desk research, competitor analysis, and surveys targeting institutional stakeholders and individual researchers. The research analyzed the Mechanical Engineering publication landscape in India and benchmarked ASME's offerings against other leading publishers. Subsequently, a set of surveys were designed, which provided insights on journal selection criteria, factors influencing research impact, and challenges affecting research output. Findings indicated that Indian researchers prioritize journals with high impact factors, strong reputations, and reasonable turnaround times for publication.

Other barriers such as inadequate funding, insufficient infrastructure, and limited collaboration opportunities are common challenges faced by researchers. Furthermore, Mechanical Engineering programs in India are experiencing declining student engagement, particularly at postgraduate level, as students increasingly opt for industry positions or studies abroad.

As an outcome of these findings, the report recommends that ASME increase its outreach and support in underrepresented areas like Design and Manufacturing through specialized workshops and collaborative initiatives. Offering publication fee waivers for low-income researchers, flexible fee structures, and reducing review turnaround times could make ASME journals more accessible. Additionally, promoting the visibility of Indian research and fostering student engagement through publication workshops, research competitions, and fellowships would help improve the overall research landscape in India.

Key technology/tools used: Python, Google Suite



Distribution Profile of Journal Selection Parameters (Lower is better)
Attribution: Naveen Punnoose

Project Partner & Sponsor:

ASME India Pvt. Ltd. (AIPL) is ASME's subsidiary in India, promoting engineering excellence and innovation across India by advancing knowledge, supporting professional development, and fostering industry collaboration.

Partner Collaborators:

- Madhukar Sharma, President, ASME India
- Tarun Arora, CEO, GIST

Naveen Punnoose

India | Mechanical Engineering

Managing Fellow
Joan Nalianya

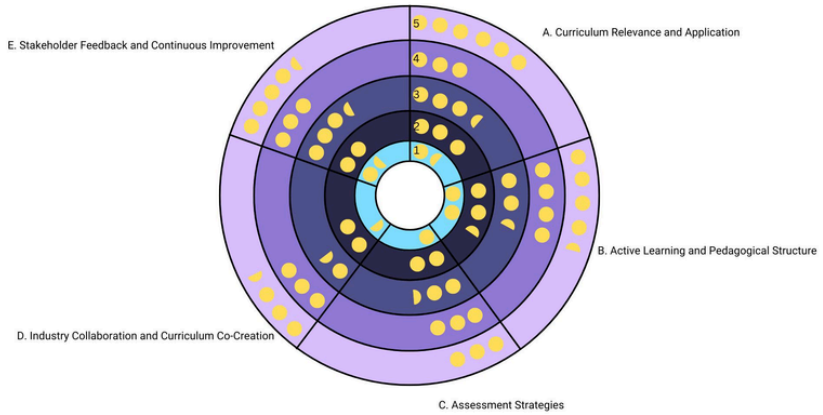
Dr. Naveen Punnoose is an Associate Professor in Mechanical Engineering and Chief Digital Officer at Saintgits College of Engineering with a Ph.D. from the National University of Singapore.

4 QUALITY EDUCATION

Mechanical Engineering Curriculum Research for India

This landscape analysis research project evaluated the effectiveness of the Mechanical Engineering curriculum in Indian universities, focusing on its alignment with industry demands, Industry 4.0 technologies, and sustainability. The goal was to identify skill gaps between academic training and industry needs, aiming to reduce "time to talent" - the period it takes graduates to become productive in industry roles.

The project involved desk research and stakeholder engagement, surveys, and interviews with 41 students, 12 academicians, and 12 industry professionals. Key reports analysed included the Autodesk-ASME Future of Manufacturing, the National Employability Report for Engineers, the AICTE Model Curriculum, and the NBA Accreditation Framework for Engineering Programmes. Expert interviews provided additional global best practices. The stakeholder engagement revealed critical gaps, with 88.9% dissatisfaction among industry professionals regarding graduate readiness and 70.7% of students feeling the curriculum is misaligned with industry needs.



Curriculum Assessment Toolkit - The Compass *Attribution: Krishna Pandikkadavil, ASME*

The analysis identified factors widening the time to talent, shaping the development of a Curriculum Evaluation Toolkit - The Compass, and a roadmap towards zero Time to Talent. The Compass Toolkit, consisting of five key parameters and 25 indicators, assesses curriculum relevance, active learning, industry collaboration, and continuous improvement. Scalable across 192 technical universities, the toolkit can impact over 1.5 million engineering students annually. A five-stage roadmap for curriculum transformation offers actionable steps and marks a critical step towards modernizing engineering education in India, ensuring curricula align with technological advancements and prepare students more effectively for emerging job markets, thus significantly reducing their adaptation time in professional environments.

Key technology/tools used: Google Suite

Naveen Krishna Pandikkadavil

India | **Humanitarian Engineering with Sustainability**

Managing Fellow
Mufaro Kanganga

Naveen, a humanitarian engineering graduate, has collaborated with research centres, MNCs, and NGOs on sustainability projects. He aims to build a career at the intersection of technology and sustainability.

Project Partner & Sponsor:

ASME
SETTING THE STANDARD

ASME India Pvt. Ltd. (AIPL) is ASME's subsidiary in India, promoting engineering excellence and innovation across India by advancing knowledge, supporting professional development, and fostering industry collaboration. Its mission is to drive solutions in Industry 4.0, sustainability, and advanced manufacturing for a global impact.

Partner Collaborators:

- Avni Malhotra, Deputy Director, AIPL
- Prof. U. Chandrasekhar, CRO Cambrian Labs & Adjunct Faculty CPDM IISc

6 CLEAN WATER AND SANITATION

Developing Assemblies and Instructional Materials for Handwashing Stations

Splash Social Enterprises (SSE), a subsidiary of Splash International, works to research and develop handwashing and drinking water stations to promote health and hygiene in low resource settings around the world. The stations are installed and maintained by local plumbers/technicians/stakeholders, so the station needs to come with comprehensive installation instructions.

However, the existing documentation for the handwashing stations is limited and assumes the user comes from a technical background and can read technical instructions in English. Neither of those assumptions are guaranteed in the contexts that SSE's stations are being used in. The project goal was to support SSE in developing a drawing standard and format that would serve the organization both now, in the effort to develop assembly/instruction materials for newly designed version of their handwashing station (HWS V3), and in future work with other versions of the handwashing station, the drinking water station, and other products.

Maintenance on a handwashing station in Ethiopia *Attribution: Mekbib Tadesse, Splash International*

From the initial steps of the work to the latest iterations of the drawings, the end user was kept in careful consideration. The station is broken down into sub-assemblies, each of which is then dissected into incremental steps that are laid out clearly and simply. The drawings do not rely on written language to communicate the assembly instructions, instead using grayscale, color blocking, symbols, and specific perspectives to communicate the information for each step.

The assembly and installation drawings that have been generated for the HWS V3 are ready to support new users as SSE begins distribution of the updated handwashing station.

Key technology/tools used: Autodesk Fusion 360, Google Suite

Zula Coley

USA | **Mechanical Engineering**

Managing Fellow
Isaac Njoroge

Technical Lead Fellow
Chinemerem Iheanacho

Zula is currently working in hydropower and is passionate about sustainable solutions and all things global development engineering. And she can almost always be found with a good cup of tea.

Project Partner:

Splash

Splash Social Enterprises (SSE) has developed drinking and handwashing stations that offer an innovative, practical, and lasting way to improve health and hygiene outcomes, ensuring that the dollars invested in the WASH sector can create long-term social benefits globally.

Partner Collaborators:

- Connie Smith, Executive Strategy Consultant
- Martin Carter, Supply and Operations Consultant

Project Sponsor:

AUTODESK FOUNDATION

6 CLEAN WATER AND SANITATION

Decarbonization of Water Sectors in the US and Germany

The global water sector is responsible for approximately 10% of greenhouse gas emissions, significantly contributing to climate change. As water and wastewater systems rely heavily on energy-intensive processes, decarbonizing the sector is essential to reducing emissions and meeting climate goals.

This project addresses the need to reduce emissions in the water sector by focusing on energy efficiency, renewable energy integration, and innovation in water operations. As the water sector faces increasing demand and environmental stressors, actionable solutions implemented in the US and Germany aimed at achieving carbon neutrality are identified.

Preliminary research explored the water sector's role in greenhouse gas emissions, followed by field visits to San Francisco and Houston. Experts from industry and academia in the US highlighted challenges such as extreme weather impacts, outdated legislation, and the use of digital tools for demand forecasting.

Visit to the San Leandro Wastewater Treatment Plant in San Francisco. *Attribution: Thomas Kiefer*

Online interviews with German experts added insights on data security, climate-adapted forecast models, and the unique challenges faced by rural and urban utilities. The synthesized findings compare approaches across both countries, with a final report summarizing key insights, emerging trends, and recommendations to accelerate decarbonization efforts in the water sector. Read the final report.

Key technology/tools used: Qualitative Research, Interviews

Chloe Kiernicki
US
Sustainable Architecture

Nick Kaiser
Germany
Mechanical Engineering

Tillmann Fuss
Germany
Infrastructure Engineering

Nancy Cai Wu
Mexico
Field Engineering

Managing Fellow
Arianna Andino

Project Partners & Sponsors:

VDI (Association of German Engineers) and **ASME** are two prominent engineering organizations that play a key role in advancing sustainable engineering practices. Both organizations provide critical technical expertise, resources, and guidance for implementing sustainable solutions.

Partner Collaborators:

- Paul Berg, Independent Expert Advisor
- Thomas Kiefer, International Affairs Coordinator, VDI
- Iana Aranda, Sustainability & Engineering Executive, ASME

7 AFFORDABLE AND CLEAN ENERGY

Development and Deployment of Net-Zero Energy Technologies within the GCC

This project aimed to strengthen the Gulf Cooperation Council (GCC)'s regional economic system to support the development and deployment of net-zero energy technologies. It involved the mapping of key private, public, and non-profit entities, analyzing funding opportunities and partnerships, and assessing the challenges and drivers for adopting these technologies.

The methodology involved desk research, stakeholder interviews, and data analysis to evaluate the maturity of the region's innovation ecosystem and compare it with global best practices. The study provided insights into the nature of funding from both public and private sectors for net-zero energy initiatives in GCC countries, the role of the private sector (such as venture capital firms) in supporting startups and innovation, and the research and development efforts of educational institutions.

Map of the Gulf Cooperation Council (GCC) countries *Attribution: Mohamed Adalbi*

The research also revealed some of the policies and incentives around renewable energy of the national governments in the GCC and how reliance on fossil fuels in the region could affect the implementation of these initiatives.

The key deliverable is a detailed research report containing a synthesis and discussion of the data obtained on net-zero energy initiatives and support within the region. The report also benchmarked the initiatives in the GCC with peer programs by other countries.

By providing insights into the potential for GCC countries to adopt net-zero energy technologies, the project can guide policies and attract interest towards reducing reliance on hydrocarbons, addressing climate change, and aligning the GCC with global sustainability goals.

Key technology/tools used: Google Suite

Mohamed Adalbi

Qatar | **Industrial Research**

Managing Fellow
Alex Inoma

Mohamed is a researcher involved in governmental projects, studying the feasibility of new projects and Qatar's national strategies. He is skilled in analysis tools and is interested in smart cities.

Project Partner & Sponsor:

The Electric Power Research Institute (EPRI) is a non-profit organization that researches to improve the generation, delivery, and use of electricity, focusing on sustainability, reliability, and environmental responsibility.

Partner Collaborators:

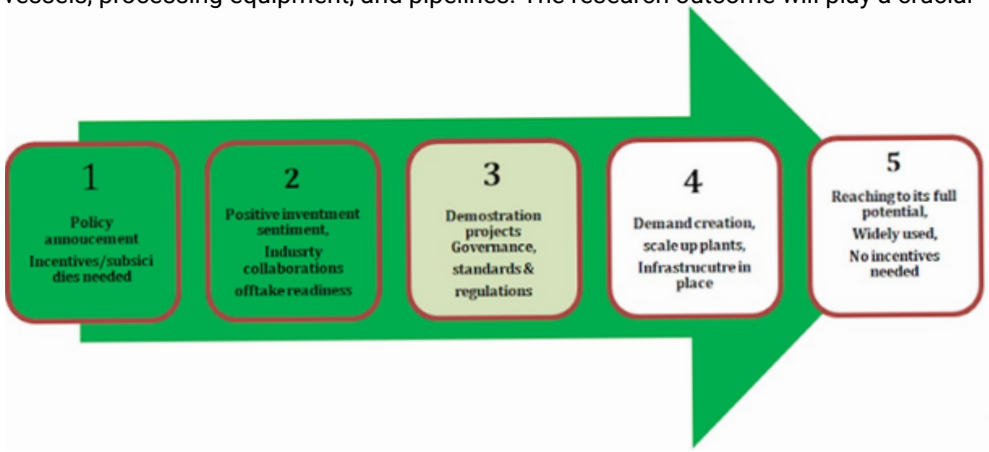
- Dan Killoren, Innovation Hub Program Manager

7 AFFORDABLE AND CLEAN ENERGY

Green Hydrogen Research for India

Green Hydrogen (GH2) will play a crucial role in achieving India's goals of energy independence by 2047 and net-zero emissions by 2070. GH2 is produced by splitting water into hydrogen and oxygen through electrolysis, using electricity from renewable sources like solar and wind. It has the potential to decarbonize various sectors such as steel, cement, and transportation, which currently rely on fossil fuels and contribute significantly to India's carbon emissions.

To support this transition, the Indian government launched the Green Hydrogen Mission in 2023, targeting production of at least 5 million metric tons of GH2 by 2030, with a total outlay of INR 19,744 crore. This mission requires an additional 125 GW of renewable energy capacity and 60-100 GW of electrolyser capacity by 2030. The main objective of this project was to investigate the current state of GH2 value chain development in India and the technology readiness of Indian industries in areas such as electrolysers, storage vessels, processing equipment, and pipelines. The research outcome will play a crucial role in developing an action plan for ASME's intervention to accelerate and support research.



The technology readiness of Green hydrogen sector in India. *Attribution: Shivaji Kale & AIPL*

Extensive research was conducted to understand the GH2 value chain in India, identify stakeholders, and study the Green Hydrogen Mission. Survey forms were prepared for various stakeholders to gather information about technical, economic, and policy challenges facing GH2 industries in India, where the sector is in its nascent stage. The landscape analysis of data collected through desk research and surveys is documented in the report, informing AIPL and ASME to strategize their future initiatives and support in this space in India.

Key technology/tools used: Google Suite

Shivaji Kale

India | Mechanical Engineering

Managing Fellow
Isaac Njoroge

Shivaji is a Mechanical Engineering Assistant Professor specializing in Energy Technology. He works as a coordinator at the EEMC, providing industrial energy audits, and has a personal interest in sustainable building design and performance analysis.

Project Partner & Sponsor:

ASME
SETTING THE STANDARD

ASME India Pvt. Ltd. (AIPL) is ASME's subsidiary in India, promoting engineering excellence through knowledge advancement, professional development, and industry collaboration.

Partner Collaborators:

- Madhukar Sharma, President, AIPL
- Dr. S. Gupta, Technical Advisor

7 AFFORDABLE AND CLEAN ENERGY

Reinforcing Freezer Lid Hinges with Enhanced Ice Battery Integration

Koolboks aims to provide cooling with solar-powered freezers equipped with ice batteries to sustain the temperature of the freezers. However, these ice batteries make the lid heavy to lift, cause deformation on the lid, and prevent it from staying open without adequate support. This project aimed to improve the hinge design of the lid carrying the ice batteries to improve the ergonomics and safety of the freezer.

To address this issue, a human-centered design approach was employed and iterated through five concept designs using surveys, research, and feedback from Koolboks' users and engineering team to arrive at the required concept. The concept separates the ice batteries from the freezer lid using a modular plastic hinge designed for each ice battery. It takes the ice battery weight off the lid while allowing the ice batteries to perform their function and still be ergonomic and user-friendly.

Detailed designs of the chosen concept were created in Fusion 360 and FEA analysis was used to improve the robustness of the design. The hinge was designed for simple and quick assembly without making any major edits to the original freezer form factor. Finally, a prototype of the hinge was 3D printed and tested, giving satisfactory results. The design is now set to be adopted by Koolboks for their future devices.

Key technology/tools used: Autodesk Fusion 360, Fusion Team

CAD design of Koolboks' 540 litre freezer used for preliminary design phase. *Attribution: Oluwatobi Oyeshile*

Brainstorming the design for the ice battery hinges.
Attribution: Oluwatobi Oyeshile and Lukmon Alani

Project Partner:

KOOLBOKS
LIFE IS KOOL

Koolboks provides affordable eco-friendly solar refrigeration products for domestic, commercial, and healthcare use. Their cooling technology makes use of ice batteries, and solar-power coupled with a pay-as-you-go device that is personalized to each customer to provide easy access to refrigeration for users in developing countries.

Project sponsor:

AUTODESK FOUNDATION

Partner Collaborators:

- Lukmon Alani, Lead Engineer
- Natalie Casey, Chief Business Officer

Oluwatobi Oyeshile

Nigeria | Mechanical Engineer

Managing Fellow
Sydney Okoroafor

Technical Lead Fellow
Chinemerem Iheanacho

Oluwatobi is a mechanical engineer with expertise in hardware design, additive manufacturing, and industrial design. He is skilled in creating innovative, efficient solutions from concept to production for diverse engineering challenges.

8 DECENT WORK AND ECONOMIC GROWTH

AI Chat Bot Integration for Learner Support

This project involved developing an AI-powered Slack bot for FreeWorld, an organization dedicated to ending generational poverty and recidivism by helping formerly incarcerated individuals secure high-wage jobs. Their digital tools provide resources, guidance and support to individuals building their careers. The bot was designed to streamline communication, answer common questions, and facilitate conversations within FreeWorld's Slack channels.

The work included creating a Slack app with necessary permissions, developing the bot using Python and the Slack Bolt framework, and integrating OpenAI's GPT-4 for natural language understanding and response generation. A web-based interface was created using Django and React, allowing the program team to update datasets. The bot was deployed on a DigitalOcean Droplet, configured with Nginx and Gunicorn for optimal performance and scalability. Additional features implemented included conversation history management, error handling, and comprehensive logging for debugging purposes.

Added monitoring to the Slack bot with Prometheus and Grafana. *Attribution: Jacinta Nalianya*

Key deliverables included a fully functional AI Slack bot, deployed and integrated with FreeWorld's Slack workspace, along with detailed documentation covering setup, configuration, coding, testing, deployment, and maintenance procedures.

The project resulted in enhanced communication efficiency within FreeWorld, allowing staff to focus on more complex tasks. The AI bot's ability to provide timely and accurate responses improved user engagement and support for Free Agents (trucking school students). The implementation of monitoring tools like Prometheus ensured system reliability and performance. The AI Slack bot improved FreeWorld's capacity to serve its community, supporting their mission to empower formerly incarcerated individuals.

Key technology/tools used: Prometheus, Gunicorn, Nginx, DigitalOcean, React, Django, Grafana, JavaScript, HTML, CSS, Python, Visual Studio

Jacinta Nalianya

Kenya | **Electronics & Machine Learning Engineering**

Managing Fellow
Sandra Sinzi Ineza

Jacinta is an innovative AI engineer with a passion for social impact. She combines cutting-edge technology with humanitarian goals to create transformative solutions, bridging the gap between artificial intelligence and global development challenges

Project Partner:

FREEWORLD

FreeWorld is a tech-enabled nonprofit dedicated to ending generational poverty and recidivism by accelerating economic mobility for returning citizens. They provide education, training, and support services to help their clients successfully reintegrate into society and break the cycle of incarceration.

Partner Collaborators:

- Jason Wang, CEO
- Marc Cull, Engineering Director

Project Sponsor:

AUTODESK FOUNDATION

8 DECENT WORK AND ECONOMIC GROWTH

Field Management and Digital Advisory App for Farmers

Oorja Development Solutions' mission is to boost economic growth and improve lives in low-income farming communities by promoting clean energy, reducing poverty, and supporting climate action. Oorja is piloting a field management and digital advisory app to further this mission and link its in-house knowledge to these farming communities. The app will offer tools like digital farmer advisory, soil health testing, and weather forecasting, focusing on usability and accessibility for farmers with low digital literacy.

The work conducted included: analyzing Oorja's brand guidelines and design preferences; reviewing existing interfaces and user journeys; designing actionable user prototype flows; gathering feedback from field tests on prototype flows; and refining prototypes for essential features like irrigation scheduling, soil health testing, and seed booking. The iterative development process allows for real-time adjustments based on the farmers' feedback, ensuring that the app meets the unique needs of its users.

The comprehensive product rollout plan, featuring two-month iteration cycles, is critical to the project's success. It encompasses strategic testing phases in selected villages, targeting different user groups prior to the full-scale product launch. Guided by a testing matrix that evaluates the ease of use, adoption, perceived value, and technical performance, the plan ensures that all critical issues are resolved, enabling smooth operation across various devices and environments. The plan includes a Strategic Post-Launch phase, with AI integration and prototyped AI use cases to enhance the app's capabilities further.

This approach ensures scalability, adaptability, and effectiveness, leading to improved operational efficiency for Oorja and increased productivity and income for farmers, driving long-term value and impact in the farming communities.

Key technology/tools used: Figma, Python, Google Suite, Visual Studio

User onboarding prototype design. *Attribution: Aditya Pandey*

Emmanuel Annor

Ghana | **Electrical and Computer Engineering**

Emmanuel is a passionate software and IoT engineer focused on developing sustainable, scalable solutions that advance accessible, affordable technologies and clean energy, driving impactful innovation and fostering growth in the industry.

Managing Fellow
Sandra Sinzi Ineza

Project Partner: OORJA

Oorja Development Solutions supports smallholder farmers in rural India through sustainable energy solutions to boost economic growth, reduce poverty, and promote climate action, improving lives in low-income farming communities.

Partner Collaborators:

- Aditya Pandey, Innovation Manager
- Dr. Clementine Chambon, CTO & Co-Founder

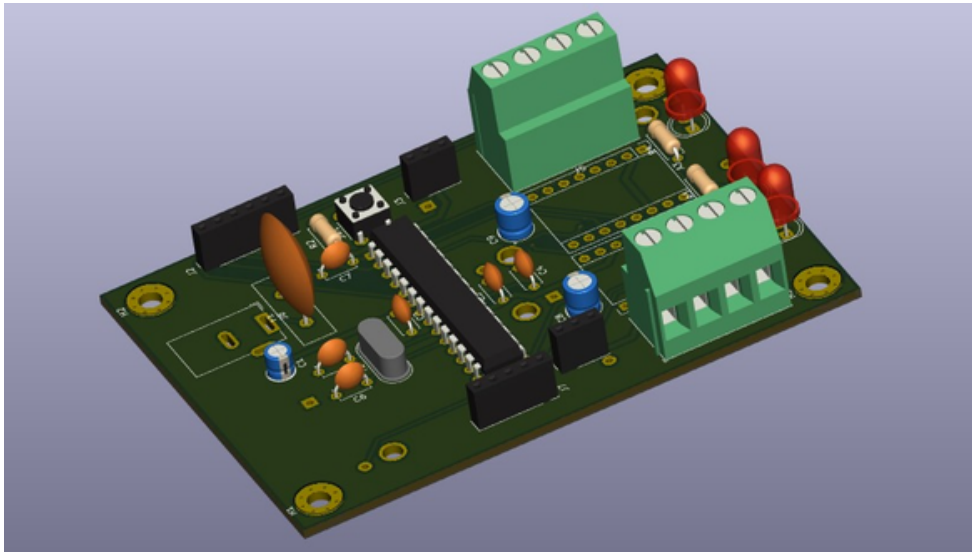
Project Sponsor: AUTODESK FOUNDATION

8 DECENT WORK AND ECONOMIC GROWTH

Design Sensor Technology for Frugal Yarn Spinning Machines

This project aimed to develop a sensor-based hardware solution to determine the thickness of frugal yarn, focusing on precision and reliability in measurement, while being user-friendly and cost-effective. To initiate the project, research on various sensor technologies was conducted, with the laser sensors ultimately being selected due to their superior performance compared to capacitive sensors.

Using Fusion 360, the initial hardware layout was designed and a dummy board created as proof of concept. This prototype facilitated essential testing and validation of the design, ensuring it met the specific requirements for measuring yarn thickness. After the proof of concept was confirmed, better-suited sensors that enhanced the system's measurement capabilities were sourced.



PCB prototype design. *Attribution: Stacy Kibarak*

A printed circuit board (PCB) that integrated these sensors was then designed, ensuring that the design was refined based on feedback and performance data gathered during initial testing. This iterative approach allowed optimization of the hardware for functionality and efficiency in yarn thickness measurement.

The key deliverables were the initial hardware layout, the dummy board for proof of concept, and the final PCB design incorporating the selected sensors. The refined hardware design significantly improved the accuracy and responsiveness of the yarn thickness measurement system, paving the way for future developments in this area.

Key technology/tools used: Autodesk Fusion 360, Google Suite, KiCAD

Stacy Kibarak

Kenya | **Electronics and Computer Engineering**

Managing Fellow
Isaac Njoroge, Kenya

Technical Lead Fellow
Chinemerem Iheanacho

Stacy is an Electronics and Computer Engineer who is passionate about blending tech with electronics. She is passionate about engineering for sustainable development and has done several projects on the same.

Project Partner:

Resham Sutra

Resham Sutra offers reliable, consistent and dignified income opportunities to make rural and tribal women self-sufficient. This is achieved through innovations that improve productivity and quality to bring greater income and comfort for rural producers.

Partner Collaborators:

- Kunal Vaid, CEO
- Upasna Jain, Chief of Staff

Project Sponsor:

AUTODESK FOUNDATION

9 INDUSTRY, INNOVATION AND INFRASTRUCTURE

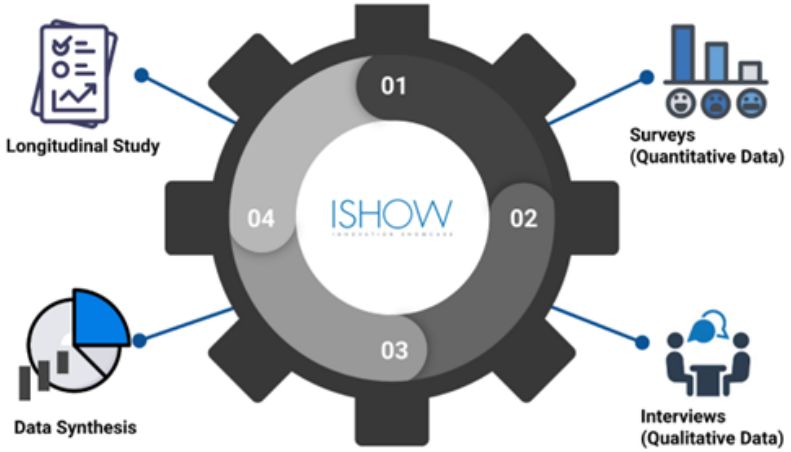
Longitudinal Study on the Impact of ASME's Hardware-Led Social Innovation Accelerator

Since 2015, ASME ISHOW, a hardware-led social innovation accelerator, has been instrumental in supporting entrepreneurial ecosystems in India, Kenya, and the United States. Over recent years, E4C Fellows have worked collaboratively with ISHOW to evaluate its impact on communities, as well as the entrepreneurial ecosystems and ventures it supports.

This project aims to enhance ISHOW's internal data collection and Social Return on Investment (SROI) initiatives for members of the global cohort. Specifically, this research contributed to an ongoing longitudinal study, gathering qualitative and quantitative data to assess ISHOW's impact on early-stage start-ups and innovation ecosystems.

This year, surveys and interviews of eight past participants of ISHOW were conducted. The data and insights gathered were analyzed and integrated into the previous year's report. Recurring themes were reinforced, and new themes emerged from the qualitative data sourced from the interviews. Building on the confidence rankings from the previous year, the strengths and weaknesses across different ISHOW regions were also identified. To conclude the Fellowship, these findings were integrated into the ongoing longitudinal study, further highlighting ISHOW's overall global impact on social entrepreneurship and innovation

Key technology/tools used: Google Suite



Process flow for the ISHOW longitudinal study
Attribution: Bethlehem Mersha

Bethlehem Mersha

United States | **Mechanical Engineering**

Managing Fellow
Sydney Okoroafor

Bethlehem is an engineer with a B.S. and an M.S. in engineering with experience as a consultant in the energy industry. She is passionate about driving sustainable change through her work in the world.

Project Partner & Sponsor:

ASME | ISHOW INNOVATION SHOWCASE

ASME (The American Society of Mechanical Engineers) is a nonprofit, membership organization for enabling collaboration, knowledge sharing, and skills development across all engineering disciplines. ASME Innovation Showcase (ISHOW) is a global accelerator of hardware-led social innovation.

Partner Collaborators:

- James Creel, Senior Program Manager, ASME
- Leah Putman, Senior Director, ASME
- Jonathan Kemp, Program Director, E4C

9 INDUSTRY, INNOVATION AND INFRASTRUCTURE

Investigating Opportunities for Strengthening the Hardware Entrepreneurship Ecosystem in East Africa

ASME, through a three-year research project funded by The Lemelson Foundation, aims to enhance its support for social innovation and expand the infrastructure for hardware technology that addresses social challenges. This project forms a larger research framework, with year one dedicated to assessing ecosystem needs, year two focusing on validating and piloting solutions, and year three aiming to scale successful strategies. This year had the specific objective of assessing the needs for ecosystem strengthening in East Africa. A roundtable discussion, held on June 19, 2024, in Nairobi, Kenya, was an integral part of this broader effort to build a robust ecosystem for hardware innovation.

The roundtable discussion brought together stakeholders from various sectors, including Entrepreneurs, Entrepreneur Support Organizations (ESOs), Funders, and Manufacturing & Industry partners. During the event, sessions were held to gather insights, where participants identified and discussed the most pressing challenges in hardware development, commercialization, and scaling within Kenya's social entrepreneurship ecosystem.

Key issues raised included limited access to funding, inadequate infrastructure, regulatory hurdles, and the need for enhanced collaboration and knowledge sharing among stakeholders.

The roundtable approach helped identify key areas where ASME can offer targeted support to address challenges and develop programs that strengthen the ecosystem. Key initiatives proposed include enhancing access to manufacturing infrastructure through infrastructure grants and shared equipment programs, facilitating technical training, online business support services, and regulatory databases. Emphasis is also placed on fostering networking and mentorship, enhancing access to finance via crowdfunding, and promoting market access through partnerships and trade fairs. These recommendations and preliminary prioritization criteria lay the groundwork for piloting and validating solutions in 2025 and 2026.

Key technology/tools used: Google Suite, Qualitative Research Skills, Data Analysis

ISHOW Kenya Roundtable Session held on June 19, 2024.
Attribution: Nancy Wangari

Project Partner & Sponsor:

ASME
SETTING THE STANDARD

ASME (The American Society of Mechanical Engineers) is a nonprofit, membership organization for enabling collaboration, knowledge sharing, and skills development across all engineering disciplines. ASME's mission is to advance engineering for the benefit of humanity.

Partner Collaborators:

- Leah Putman, Senior Director, ASME
- Ash Seth, Strategy Consultant, E4C

Nancy Nyawira Wangari

Kenya | **Electrical Engineering**

Managing Fellow
Sydney Okoroafor

Nancy Wangari is an engineer with a B.Eng in Electrical Power Systems. She works as a Project Engineer on energy projects across East Africa.

9 INDUSTRY, INNOVATION AND INFRASTRUCTURE

Entrepreneurship Landscape Research India

India's hardware entrepreneurship landscape faces significant challenges but holds vast potential for growth and innovation. Limited access to funding, infrastructure gaps, and a fragmented ecosystem have long hindered the sector. However, the landscape is rapidly evolving with an increasing focus on social impact and technology-driven entrepreneurship. Hardware investments have surged from 0.6% between 2014 and 2020 to 11% in 2023. To address these challenges and unlock new opportunities, ASME embarked on this project to strengthen India's hardware innovation ecosystem and amplify its social impact.

The project's objective was to develop a strategy for ASME India Pvt. Ltd. (AIPL) to support the growth of social innovation and hardware entrepreneurship. It focused on three key tasks: developing a strategy for AIPL to expand its regional focus; creating actionable programmatic strategies for AIPL to bridge gaps in the hardware ecosystem; and mapping potential funders in India who could support future ASME programs. These efforts are part of a broader, three-year research and strategic planning initiative funded by The Lemelson Foundation.

Key objectives achieved during the project. *Attribution: Tanmay Nag*

The groundwork for this project involved analyzing entrepreneurship funding trends and examining how regional entrepreneurship hubs are emerging. This analysis informed a three-tiered strategy for AIPL, which included developing national programs for wider outreach, strengthening partnerships in mature start-up regions, and establishing foundations in emerging hubs. This strategy will help localize ASME's global programs, such as ISHOW and IdeaLab, in India and enhance support for hardware entrepreneurship.

Key deliverables included a strategy for localizing ASME's global innovation programs in India, developing programmatic interventions to strengthen regional ecosystems, and creating a funder database to guide collaboration and partnership opportunities. These will help AIPL expand its support for hardware innovators, promote social impact, and foster a culture of sustainable, technology-based entrepreneurship across the country.

Key technology/tools used: Google Suite

Tanmay Nag

India | Environmental Engineering

Managing Fellow
Sydney Okoroafor

Tanmay is an engineer who finds meaning in solving societal grassroots problems. He recently built a climate startup - Enveave.earth after working as a management consultant with EY and PwC.

Project Partner & Sponsor:

ASME
SETTING THE STANDARD

ASME India Pvt. Ltd. (AIPL) is ASME's subsidiary in India, promoting engineering excellence and innovation across India by advancing knowledge, supporting professional development, and fostering industry collaboration.

Partners Collaborators:

- Avni Malhotra, Deputy Director, AIPL
- Ash Seth, Strategy Consultant, E4C
- Chanda Daas, AIPL

9 INDUSTRY, INNOVATION AND INFRASTRUCTURE

CFD Flow Distribution for Electrolysis Cell

Nth Cycle is a metal refining company that uses electro-extraction technology to recover critical metals from industrial scrap, low-grade minerals and mining waste streams. Nth Cycle is closing the mining production loop and making metals infinitely reusable. The project aims to use CFD to improve the design and performance of their gas transporting pipes and core technology for critical material refining, with objectives to enhance flow distribution, improve manufacturability, and optimize overall performance.

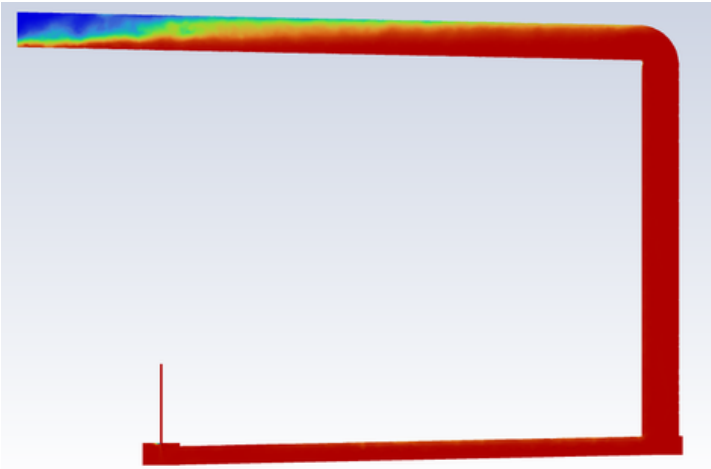
The work focused on analyzing four key components: production gas dilution, production gas purging, liquid flow distribution in the core technology, and ambient gas diffusion at commercial scales. For production gas dilution, simulations of the mixing of production gasses with air in system piping were conducted, analyzing velocity and concentration profiles for various inlet configurations. Production gas purging simulations explored methods to efficiently remove production gasses from system piping, leading to improved purging efficiency through geometric modifications.

Analysis of liquid flow through distribution networks within Nth Cycle's core technology was performed, with multiple design iterations to achieve more uniform flow distribution. Additionally, ambient gas diffusion at commercial scales was simulated to provide operational insights.

Design concepts were modeled in Fusion 360 and Autodesk CFD was used to perform the CFD simulations. The computational domain used in the CFD analysis was modeled to mirror real-world operating conditions in the lab and plant settings. Key deliverables were the CAD Files, CFD Files, CFD outcome report and recommendations on the simulation results.

The project demonstrated the effective use of CFD analysis in optimizing complex fluid systems, resulting in promising improvements in the efficiency and safety of Nth Cycle's core technology and plant operations.

Key technology/tools used: Autodesk Fusion 360, Autodesk CFD, Google Suite



Nitrogen Purging of Hydrogen *Attribution: Shanmugam Rengaswamy Murugan for Nth Cycle*

Project Partner:

NTH CYCLE

Project Sponsor:

AUTODESK FOUNDATION

Nth Cycle is an industry leader in critical metal refining. They recover production-grade critical metals from industrial scrap, low-grade ore, and refining waste. Their patented electro-extraction technology enables clean, and consistent recovery of the critical metals for the energy transition.

Partner Collaborators:

- Bill Caruso, Snr Mechanical Engineer
- Josh Gervais, Mechanical Engineer
- Stephen Wei, Mechanical Engineer

Shanmugam Rengaswamy Murugan

USA | Mechanical Engineering

Managing Fellow
Isaac Njoroge

Technical Lead Fellow
Chinemerem Iheanacho

Shanmugam is a mechanical engineer with a passion for innovative and sustainable design, transforming problems into practical solutions. His goal is to push the boundaries of engineering while continuing to grow and adapt.

9 INDUSTRY, INNOVATION AND INFRASTRUCTURE

Optimizing Workflow for Analyzing Climate Impact Potential

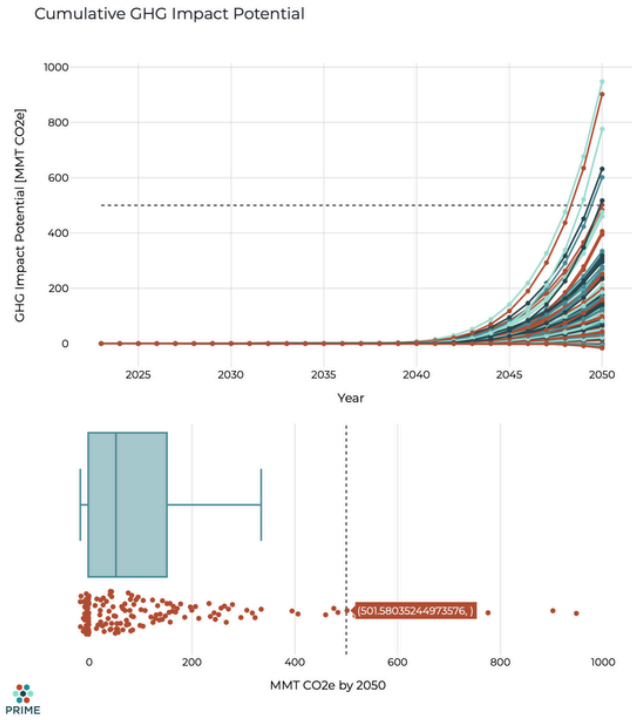
This project aimed to streamline Prime Coalition's workflow to assess the climate impact potential of ventures seeking funding from Azolla Ventures. Azolla, founded by Prime, supports ventures working on transformative climate solutions with catalytic capital. The primary objective was to create a robust, user-friendly template for quantitative climate impact analysis, incorporating advanced features like sensitivity analysis, scenario modelling, and optimization techniques.

To accomplish this, stakeholders were interviewed to understand their specific needs, and current analytical tools were assessed. The initial focus was on identifying stakeholder requirements, then breaking down existing workflows and creating reusable custom functions with Python. Platforms like Google Colab and Deepnote were recommended to allow accessible, flexible collaboration across various systems and to make executing and sharing analyses easier. Key functions developed included models for market penetration and growth, data visualisation tools, and evaluation functions for diverse climate impact scenarios.

The primary deliverable was a fully modular analysis template featuring custom functions for evaluating greenhouse gas (GHG) impacts. This included comprehensive documentation and training materials. The project also offered user interface recommendations to make the template accessible to both technical and non-technical users.

The impact of this work lies in enhancing the efficiency, accessibility, replicability, and accuracy of climate impact analysis. This advancement enables Prime Coalition and Azolla Ventures to more effectively assess and invest in solutions with the potential to substantially reduce or remove greenhouse gas emissions.

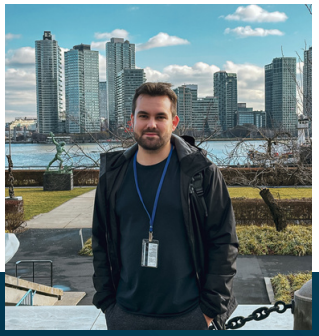
Key technology/tools used: Python, Google Suite, Visual Studio



Visual output showing cumulative GHG impact trends and a 2050 impact distribution boxplot. *Attribution: Felix Schwebel*

Felix Schwebel

Germany | Industrial Engineering



Felix is an Industrial Engineering student at the University of Hamburg, passionate about applying technological advancements for societal good. He supports UNICEF with communication, project management, and data science to create impactful, frontier tech solutions.

Managing Fellow
Sandra Sinzi Ineza

Project Partner: PRIME

Prime Coalition is a non-profit on a mission to unlock catalytic capital and change the future of climate finance. Since 2015, Prime has mobilized over $315MM with 247 partners, supporting 38 early-stage ventures through impact-first investing and offering resources like Project Frame and the CRANE tool.

Partner Collaborators:

- Jenny Zhang, Impact Manager
- Anna Goldstein, Director of Impact

Project Sponsor: AUTODESK FOUNDATION

9 INDUSTRY, INNOVATION AND INFRASTRUCTURE

Building a Way for Data Scientists to Test SDKs with Large Datasets

Global poverty remains a significant challenge, with up to 29% of global aid failing to achieve its intended outcomes due to issues like bribery, theft, and embezzlement, costing $500 billion annually in health expenditure. To address these inefficiencies, Simprints is partnering with governments, NGOs, and donors to provide biometric solutions for improved program monitoring, beneficiary identification, and coverage verification.

This project focused on developing a pipeline for data scientists to test fingerprint software development kits (SDKs) using large biometric datasets. Simprints aimed to select the SDK that best aligned with their needs and future goals.

The primary task was to develop a pipeline for testing fingerprint SDKs. This involved breaking the work into sub-tasks, such as building bash scripts for individual functions, testing each component with synthetic data on a local machine, and eventually deploying the solution in a Docker container for cloud-based execution. Each sub-task was thoroughly tested to ensure it worked effectively within the larger pipeline.

The key outcome was the development of a pipeline that data scientists can use to test their fingerprint SDK.

Key technology/tools used: Bash Scripting

Fingerprint. *Attribution: Wikipedia*

Project Partner:

simprints
every person counts

Project Sponsor:

AUTODESK FOUNDATION

Simprints, a nonprofit founded at the University of Cambridge, creates biometric identification tools and contactless face scanning solutions for governments and NGOs. Their mission is to combat poverty and disease by ensuring legal identity for underserved communities in low-income countries.

Partners Collaborators:

- Bastien Micheau, Engineering Manager

Deogratias Amani

Rwanda | **Computer science and Artificial Intelligence**

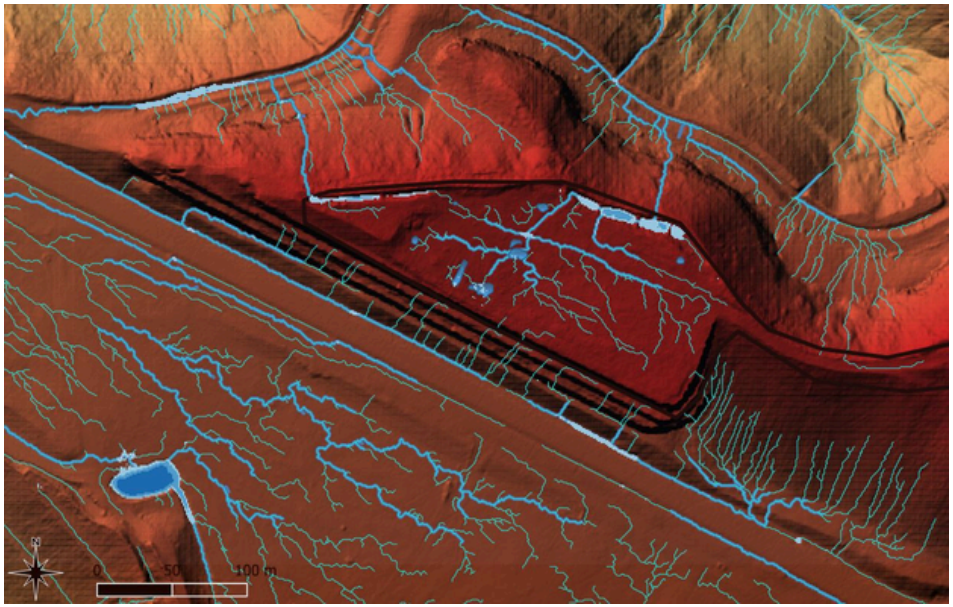
Managing Fellow
Sinzi Ineza Sandra

Deogratias is a polymath and fun; he holds a masters in Engineering Artificial Intelligence from Carnegie Mellon University and a bachelors in computer science from the African Leadership University.

11 SUSTAINABLE CITIES AND COMMUNITIES

Design for Sustainable Water Management and Ecological Restoration

The Coalfield Development Highwall Project site, located in Mingo County in southern West Virginia, is a former coal extraction mine site currently undergoing restoration. Coalfield Development crews are currently on site working to improve the site's ecology, utilizing permaculture and regenerative agriculture practices to rebuild the natural health of the land, but the site experiences intensive rain events in ponding on various areas. The goal of this project was to manage the stormwater sustainably while maintaining soil quality, to further the restoration of the land to its original ecology.



Flow paths of the terrain generated from a watershed analysis.
Attribution: Mercy Atukunda

Assessments including slope analysis, watershed analysis, and a stormwater management model were completed to inform the design of vegetated drains to convey stormwater to a retention basin designed to store it for re-use. Key deliverables included a report summarizing these assessments and 2D drawings of the channels and basin.

The project piloted a sustainable approach to water management on a former mainland site, and identified some sitewide water management practices that will continue to support Coalfield Development's restoration work such as erosion and sediment control measures. It also resulted in the design of vegetated drains to minimize local flooding, especially after heavy rainfall events, and the design of a retention basin to harvest the stormwater for re-use in the site's farm activities.

Key technology/tools used: Autodesk AutoCAD, QGIS, Deswik, Google Suite

Mercy Atukunda

Uganda | **Civil and Environmental Engineering**

Managing Fellow
Joan Nalianya

Technical Lead Fellow
Symon Kipkemei

Mercy is currently undertaking a Master's degree in Civil Engineering/Project Management at Griffith University. She is a student engineer (BSc. Civil & Environmental) in the closure & remediation team at Engeny.

Project Partner:

COALFIELD DEVELOPMENT
REBUILDING THE APPALACHIAN ECONOMY FROM THE GROUND UP.

Coalfield Development is a non-profit organization focused on rebuilding the Appalachian economy. Their work involves repurposing old coal mining infrastructure and supporting sustainable development through community development, workforce training, and environmental restoration.

Partner Collaborators:

- Nick Guertin, Senior Director
- Cassidy Riley, Senior Director of Conservation
- Kaleb Hanshaw, Director of Reclamation and Remediation

Project Sponsor:

AUTODESK FOUNDATION

Building Energy Modelling and Environmental Design Workflow

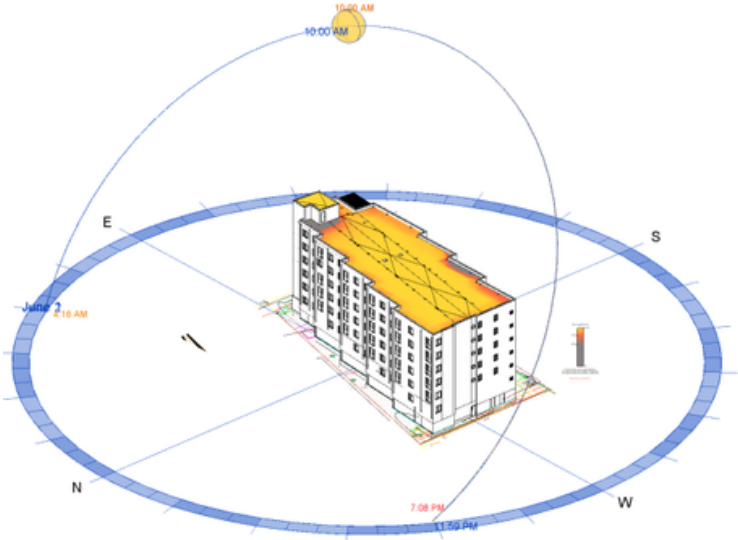
Given its substantial contribution to global energy use and greenhouse gas emissions, the construction industry faces significant challenges in reducing operational energy consumption and carbon emissions while maintaining high-quality indoor environments. MASS Design Group addresses these challenges by minimizing environmental impact from early design stages and recognizing architecture's broader influence.

With an identified opportunity to enhance the energy analysis process by integrating advanced building information modeling (BIM) and energy simulation tools across all project stages, this project aimed to assist MASS Design Group's design teams in enhancing their capabilities to reduce operational energy and carbon impacts while improving indoor environmental quality, specifically by utilizing Revit Insight and Systems Analysis capabilities.

The project involved demonstrating Revit's capabilities for various analyses, including lighting, solar, carbon insight, annual building energy simulation, and HVAC load and sizing. Also, a comparative analysis between Revit tools and WUFI was conducted using a MASS Design Group architectural model. Metrics such as Energy Use Intensity and HVAC loads were analyzed, informing recommendations for software applications at different AIA (American Institute of Architects) work stages.

The project culminated in the development of a robust workflow for MASS Design Group, guiding them in the execution of whole building energy analysis at different stages of work using Revit Insight and Revit Annual Building Energy Simulation. The project's outcomes are expected to streamline MASS Design Group's approach to energy analysis, potentially leading to more energy-efficient and environmentally responsible designs.

Key technology/tools used: Autodesk Revit Insight, WUFI, Google Suite



Solar analysis on MASS Design Group's architectural model.
Attribution: Henry Chigozie Mpieri

Project Partner:

MASS.

Project Sponsor:

AUTODESK FOUNDATION

MASS Design Group is a non-profit architecture firm committed to creating architecture that promotes justice, human dignity, and sustainability. They believe in the power of design to tackle global challenges and improve lives through thoughtful, contextually-responsive built environments.

Partner Collaborators:

- Chris Hardy, Design Director
- James Kitchin, Director of Performance & Provenance
- Francis Fotsing, Energy Engineer

Henry Mpieri

United Kingdom |
Electrical/Electronic Engineering

Managing Fellow
Joan Nalianya

Technical Lead Fellow
Symon Kipkemei

Henry, an Electrical/Electronic Engineering graduate, recently completed an MSc in Advanced Energy Technologies for Buildings & Industry. He is dedicated to driving sustainable building solutions in the built environment.

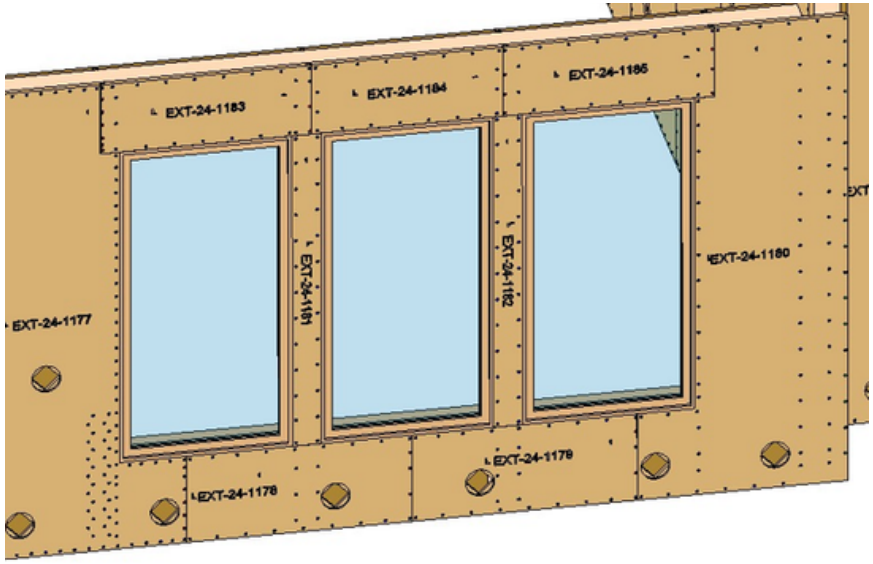
11 SUSTAINABLE CITIES AND COMMUNITIES

Revit Tool to Detect Non-Hosted Elements

BamCore manufactures innovative structural panels made from bamboo, eucalyptus, and plywood, designed for rapid on-site assembly in residential construction. During the panel fabrication preparation in Revit, a common issue arises where certain elements, especially nails, become detached from their host panels. The existing "Reconcile Hosting" tool in Revit has limitations, particularly its inability to process specific model sections, making the correction process manual, tedious, and time-consuming.

To address this challenge, a custom Revit API solution was developed using C# and Python. This tool now automates the rehosting process, allowing users to efficiently reattach orphaned elements with a single click, saving considerable time when transferring the CAD models for fabrication.

Key technology/tools used: Autodesk Revit, Google Suite, Python Programming, C#



BamCore walls with associated elements.
Attribution: Image created using Autodesk Revit by Hazem Kahla

James Mbonabucya

Rwanda | **Software Engineering and Cyber Security**

Managing Fellow
Ogechi Ogbonna

Technical Lead Fellow
Symon Kiplelgo Kipkemei

James is a highly skilled Cyber Security and Full-stack Software Engineer with a specialty in the design and development of cloud-based solutions. He is eager to learn new technologies and has a drive to reduce cloud costs.

Project Partner:

BAMCORE

BamCore is addressing the pressing issue of the construction industry's significant carbon footprint, which accounts for nearly 40% of global greenhouse gas emissions. The organization's objective is to revolutionize construction with low-cost and carbon-negative solutions.

Partner Collaborators:

- Hazem Kahla, Architectural Engineer and VDC Manager
- Theo Morrow, Director of Job Design

Project Sponsor:

AUTODESK FOUNDATION

11 SUSTAINABLE CITIES AND COMMUNITIES

Structural Research and Design for Sustainable Housing Pilots

Construction using locally sourced materials can lower carbon emissions and also promote affordable housing. In addition, it addresses the growing global demand for sustainable shelter solutions. Statistics from UN-Habitat suggests that three billion people will need access to adequate shelter by 2030. As a result, developing innovative earth-based construction methods and reviving traditional building techniques are essential to closing the global housing gap while providing affordable and sustainable solutions.

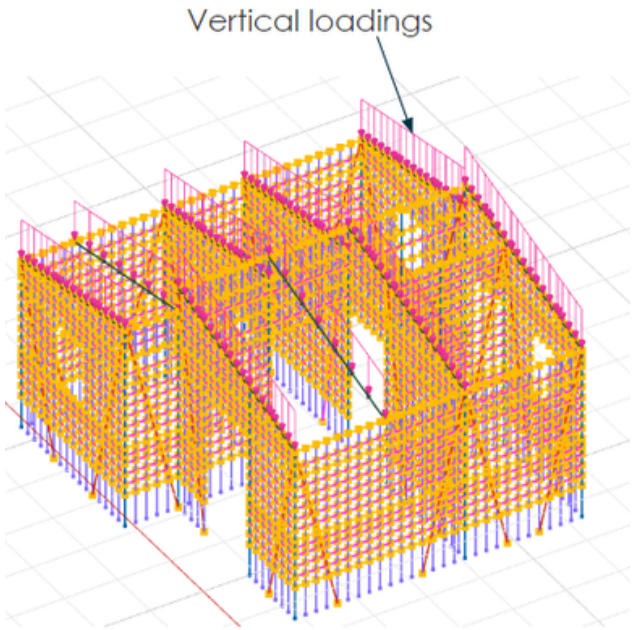
The objective of this project was to develop the wood and earth-based construction system known as wattle and daub. EarthEnable had previously designed and constructed three prototype homes using adobe block as the primary walling system. However, this project aimed to conduct research and testing on wattle and daub as an alternative, with the goal of further developing the designs and potentially replacing adobe with wattle and daub as the main construction material.

Field and desk research were conducted to collect information on how wattle and daub houses are traditionally built and their modern adaptations in other regions. This was followed by the analysis and design of the modelled houses. CAD drawings and analytic models were first produced, enabling the design and development of prototypes. This was followed by the costing, which was compared with those of adobe prototypes.

Lastly, construction guidelines and best practices for constructing wood and mud-based buildings was developed.

The key deliverables of the project were wattle and daub designs and cost comparison report, along with construction best practices. This aims to enhance its sustainability and promote its use as an affordable housing alternative.

Key technology/tools used: Autodesk Revit, AutoCAD, Robot Structural Analysis, GSA



Wattle and daub structural model.
Attribution: Model created using GSA Structural Analysis by Ange Umutoni

Ange UMUTONI

Rwanda | **Civil Engineering**

Ange is a professional civil/structural engineer from Rwanda with a strong interest in nature-based solutions. Her enthusiasm for infrastructure enhancement is matched by her dedication to promoting sustainable and green building practices.

Managing Fellow
Ogechi Ogbonna

Technical Lead Fellow
Symon Kiplelgo Kipkemei

Project Partner: EARTH ENABLE

EarthEnable is on a mission to solve the housing crisis in Rwanda and beyond through sustainable, affordable and healthy home solutions. It develops responses to housing challenges in underserved communities and is a key source of earthen construction practices.

Partner Collaborators:

- Athanase Nzayisenga, Director of Research and Development
- Rosie Goldrick, Chief Technology Officer

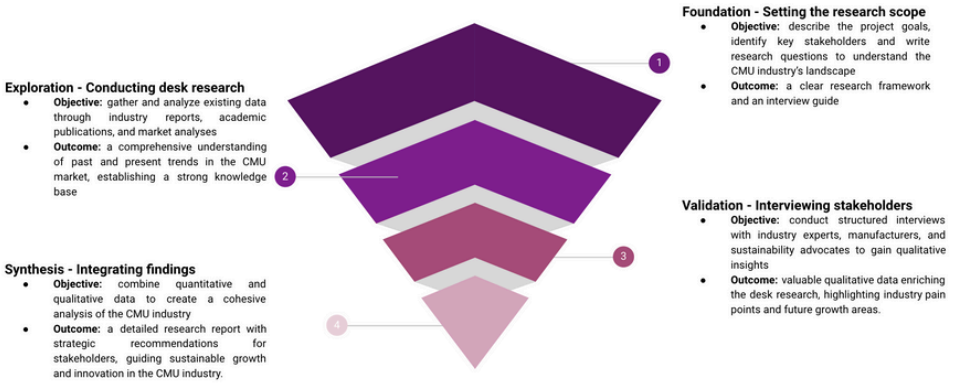
Project Sponsor: AUTODESK FOUNDATION

12 RESPONSIBLE CONSUMPTION AND PRODUCTION

Supply and Demand Analysis of North American Supplementary Cementitious Materials

The Concrete Masonry Unit (CMU) industry is currently undergoing a significant transformation, driven by a growing demand for sustainable and resilient building materials. It is thus important to understand the dynamics of the CMU market to capitalize on emerging opportunities and navigate future challenges. This project focused on providing a comprehensive landscape analysis of the CMU industry, examining current market conditions, future growth projections, and key factors influencing its trajectory.

The research was conducted in two main phases: desk research and stakeholder interviews. Desk research involved an extensive review of industry reports, market trends, and academic publications to map out the historical evolution of CMUs, assess regional market variations, and explore technological advancements. This foundational analysis provided a robust framework for understanding the market's trajectory. To complement the desk research, in-depth interviews were conducted with key stakeholders, including industry experts, manufacturers, and sustainability advocates. These interviews offered real-time insights into the challenges and opportunities within the industry. The integration of both quantitative data and qualitative insights ensured a holistic view of the market.



Navigating the CMU industry: a step-by-step research process. *Attribution: Oumaima Makhlouk*

The project culminated in a detailed research report, which included a thorough analysis of market conditions, future projections, and strategic recommendations for industry stakeholders. The report emphasized the importance of investing in low-carbon CMUs and adopting automation technologies to enhance production capacity and address labor constraints.

The research findings can provide guidance for CMU stakeholders. By highlighting the critical role of sustainable practices and technological innovation, the project can influence strategic decisions within the industry, encouraging investments in low-carbon solutions and advanced manufacturing techniques. These insights can help to justify the development of more resilient and environmentally friendly CMUs, supporting the industry's adaptation to evolving market demands and contributing to broader sustainability goals.

Key technology/tools used: Google Suite

Oumaima Makhlouk

Morocco | Data Science

Managing Fellow
Alex Inoma

Oumaima is passionate about leveraging technology and data-driven solutions to address SDGs. She works with the UN Datathon and the World Bank to drive sustainable innovation.

Project Partner:

CARBONBUILT
ULTRA-LOW CARBON CONCRETE

CarbonBuilt's mission is to enable concrete manufacturing to achieve significant emissions reductions through the use of industrial byproducts and captured CO_2. CarbonBuilt provides solutions that replicate traditional cement performance while reducing carbon footprints, without compromising cost or efficiency.

Partner Collaborators:

- Camly Tran, Head of Operations
- Cindy McLaughlin, Head of Carbon Impact

Project Sponsor:

AUTODESK FOUNDATION

12 RESPONSIBLE CONSUMPTION AND PRODUCTION

Digitalization of Community Center in New York City

Experts and scientific research state that obtaining a post-secondary degree is a huge indicator of higher wages, financial stability, and increased opportunities. However, many students do not have the means to fund higher education. Stacks+Joules (S+J) is a nonprofit that provides opportunities for students to gain skills in computer programming and coding, specifically in relation to hardware and IoT. S+J is housed in the Diversity in Automated Buildings (DAB) Laboratory at the Henry Street Settlement in the Lower East Side of New York City. S+J has partnered with Burro Happold, a civil engineering firm, in implementing newer retrofits at Henry Street. The plan is to scale the retrofitting process into other similar buildings around New York City.

For this project, research was conducted to identify other nonprofit organizations that were of similar building and employee size, as well as those that had similar financial statuses, specifically revenue, expenses, and capital expenditures. Additionally, further research was conducted into the processes that each of the stakeholders had employed over the past year to initiate the retrofitting project.

The main deliverable was the scalability report. The report summarizes steps taken to determine the current state of equipment, how machine workflows were analyzed, the technology that was installed as improvements, and how scaling processes could be initiated. The report also creates an outline for future steps.

This report will help other small businesses, particularly nonprofits, develop better building conditions and reduce carbon emissions, contributing to a healthier environment. Additionally, this project will allow students from the S+J curriculum to gain experience with retrofitting and data analysis systems, thus enriching their learning and skill sets for the workforce.

Key technology/tools used: Autodesk Revit, Google Suit

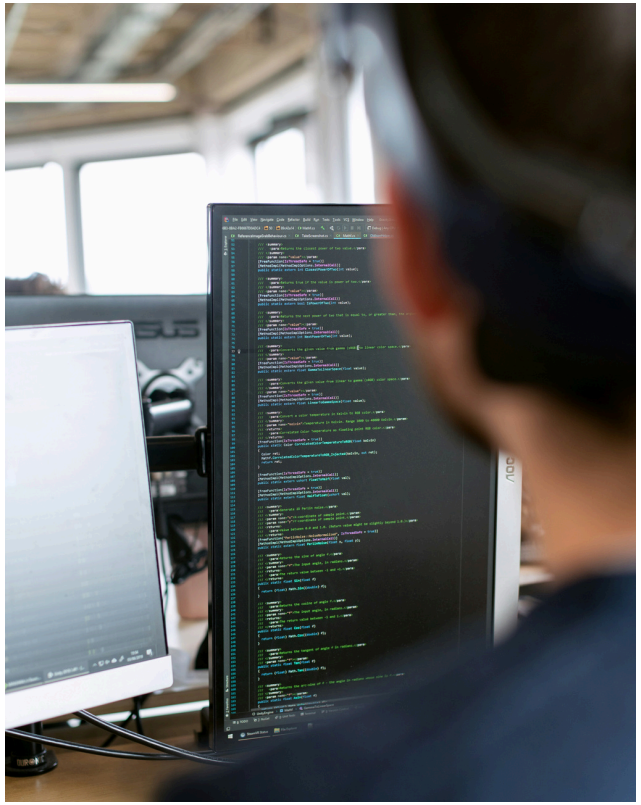


Photo by ThisisEngineering
Attribution: Unsplash

Sejal Jinturkar

United States |
Mechanical Engineering

Sejal has a mechanical engineering and data science background. She is passionate about using technical skills to build solutions to help people in underserved communities.

Managing Fellow
Joan Nalianya

Technical Lead Fellow
Symon Kipkemei

Project Partner: STACKS+JOULES

Stacks+Joules is a project-based learning program in computer programming and wireless network management. The specialized curriculum engages young individuals' creativity to increase their technical skillsets and prepare them for the workforce.

Partner Collaborators:

- Jon Spooner, Founder

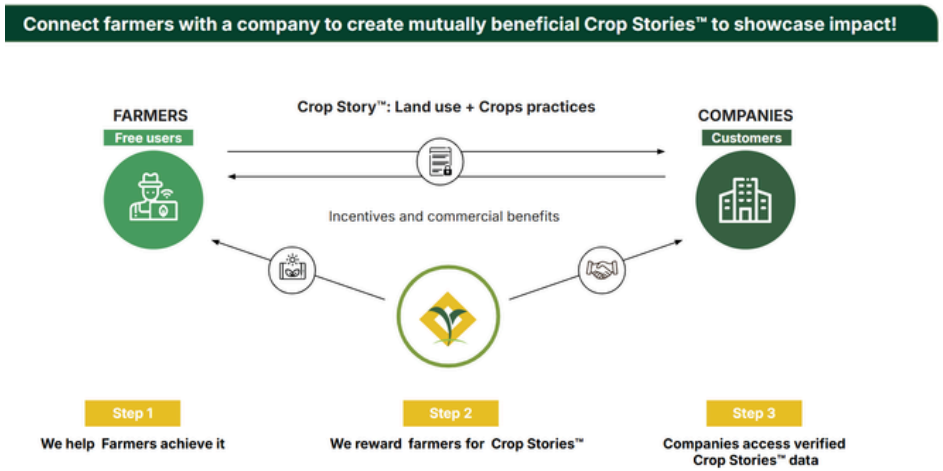
Project Sponsor: AUTODESK FOUNDATION

12 RESPONSIBLE CONSUMPTION AND PRODUCTION

Advancing Sustainability Metrics in Agriculture

Agriculture contributes 21-37% of global emissions, from methane and nitrous oxide emissions and carbon dioxide from deforestation. Land use and water management changes also affect regional and global climates. To mitigate these effects, adopting innovative technologies, supportive policies, and sustainable farming methods is essential for balancing food production with environmental sustainability. ucrop.it's innovative platform enhances agricultural management, making monitoring accessible, transparent, and accurate. Its approach allows organizations to align their sustainability goals with tangible, scalable, and auditable incentives for farmers.

This report analyses the landscape and evaluates ucrop.it's existing technologies to address traceability and verification of sustainability claims. It outlines opportunities to enhance sustainability metrics in the biofuel sector, consumer packaged goods, green financing, sustainable landscapes, and farmer governance.



ucrop.it relationship diagram with farmers and companies. *Attribution: ucrop.it*

Data collection methods included a review of existing literature and company databases, along with interviews where stakeholders were engaged through structured conversations to gather first-hand data. The collected data was synthesised and analysed, identifying key themes and quantifiable performance measures. The deliverables include new and improved Key Performance Indicators (KPIs) designed to measure, monitor, and assess the environmental and social impacts of agricultural activities. The areas of focus include landscape sustainability, farmer governance, greenhouse gas accounting, the biofuel sector, and the consumer packaged goods sector. These enhanced KPIs will support ucrop.it's operational efficiency by facilitating research-informed innovation and decision-making. This research responds to growing consumer and business demands for evidence of sustainable practices, ultimately improving ucrop.it's ability to support sustainable agriculture.

Key technology/tools used: Google Suite

Barbara Ayuma Maina

Kenya | **Environmental and Biosystems Engineering**

Managing Fellow
Mufaro Kanganga

Ayuma bridges policy and fieldwork, designing products, projects, and processes for natural resource efficiency, while supporting resilient communities and businesses through sustainable engineering in agriculture & water management.

Project Partner:

ucrop.it

ucrop.it is an agritech company with an innovative platform that enhances agricultural management, making monitoring accessible, transparent, and accurate. With a robust ground-proof MRV for traceability, it supports verified sustainable agriculture from farm to market, ensuring impact on sustainability claims.

Partner Collaborators:

- Ezequiel Esnaola, CFO
- Santos Piccardo, Financial Business Developer

Project Sponsor:

AUTODESK FOUNDATION

13 CLIMATE ACTION

Investigating Sectors with Insufficient Public Domain Data to Determine Investment Feasibility

In order to meet the climate goals set out in the Paris Agreement, it has been recognised that the deployment of carbon dioxide removal (CDR) technologies is necessary. Private investment is a critical financing instrument for CDR technologies to develop and scale. Since most CDR technologies are nascent, there persists a gap in public domain data used to inform investment decisions. The research explores the investment feasibility of biochar, an emerging sector that contributes to carbon sequestration while improving soil health, specifically focusing on the Global South.

For this project, desk research and meetings with stakeholders in the biochar startup space were carried out to gain a deeper understanding of the technology used to produce biochar, current business models, and insights on the future of the global biochar industry. An investment thesis was developed which presents a landscape analysis of the industry and insights used to help inform investment decisions in the space.

Biochar ready for soil application.
Attribution: GIZ Bush Control and Biomass Utilisation Project (CC-BY-SA-4.0)

It was found that generally in the Global South (particularly South America and Africa), the sale of biochar carbon credits drives revenue as opposed to the sale of biochar itself. There are, however, successful cases of biochar companies diversifying revenue streams through the sale of bio-oil or through strategic marketing of biochar to farmers.

Based on the sector's anticipated growth, now is an opportune time to explore the industry from an investment perspective. India's biochar market is emerging, with its current infancy linked to a lack of market awareness. However, it is crucial to identify a strong, scalable, and sustainable business model, given the likelihood that the biochar startup space will become increasingly competitive by 2030.

Key technology/tools used: Google Suite

Ashna Jain

Canada | Industrial Engineering

Managing Fellow
Mufaro Kanganga

Ashna, an industrial engineering student at the University of Toronto, aims to implement and scale system-based solutions to address global challenges through her education and career.

Project Partner:

synapses

Synapses is a seed and early stage venture fund based in India. It is focused on providing strategic, operational, and capital support to innovations in climate and health to create global market leaders. Synapses focuses on engineering solutions that present sustainable solutions.

Partner Collaborators:

- Karthik Chandrasekar, Founder
- Apurva Kedia, Investment Analyst & EA

Project Sponsor:

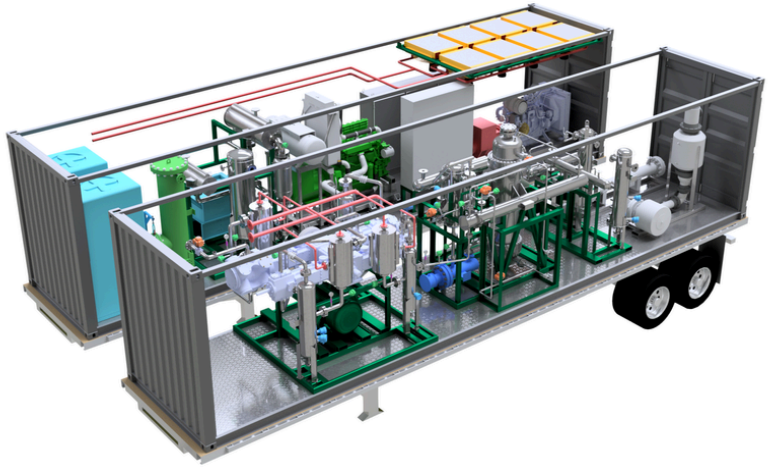
AUTODESK FOUNDATION

13 CLIMATE ACTION

Design of Transportable Process for Reduction of Global Methane Emissions

Gas flaring occurs when natural gas, a by-product of oil extraction, is burned off due to a lack of infrastructure to capture, store, or transport it. This process releases a substantial amount of methane, CO2, and other pollutants, contributing to climate change and harming local air quality. Economically, gas flaring represents a significant waste, as the flared gas could be utilized to produce energy or valuable chemical products, contributing to economic growth and resource efficiency (GFMR, 2023).

M2X Energy has pioneered the production of low-carbon methanol from stranded natural gas using a patented process. This technology captures natural gas emissions from major sources like oil fields, landfills, and wastewater treatment plants and converts them into liquid methanol. It presents a scalable and economically viable solution for managing greenhouse gas (GHG) emissions by repurposing stranded gas into methanol.



M2X Containerized Gas-to-Methanol System for Global Deployment.
Attribution: Williams Ibeh & M2X Energy

Built on this existing framework, this project provided valuable engineering support focused on transitioning M2X's trailer-based gas-to-methanol plant into a containerized system for rapid deployment worldwide. A modular (sub-skid) design approach was used to fit and integrate all the modules within two 40-feet ISO shipping containers. Significant attention was placed on the configuration of the modules, to optimize system layout, reduce capital costs, and enhance manufacturability, assembly, and servicing. This resulted in outputs such as optimized equipment and piping designs, 3D models, structural analysis, renderings, and detailed engineering files, which would assist M2X with scale-up, manufacturing, and global deployment of their GHG mitigation technology.

Key technology/tools used: Autodesk Inventor

Williams Ibeh

Nigeria | Mechanical Engineering

Managing Fellow
Sydney Okoroafor

Technical Lead Fellow
Chinemerem Iheanacho

Williams is a Design Engineer in the steel fabrication and manufacturing industry, with a B.Eng. in mechanical engineering. He craves forward momentum in all aspects of his life and career.

Project Partner:

M2X

M2X Energy has developed a patented process that produces low-carbon methanol from stranded natural gas, capturing emissions from sources like oil fields and landfills. In 2023, they successfully demonstrated their first commercial-scale unit, proving its viability. The company is now expanding manufacturing to deploy more units for emission reduction

Partner Collaborators:

- Nicholas Schwartz, Director of Product Engineering/Manufacturing
- Josh Browne, Co-founder & CEO

Project Sponsor:

AUTODESK FOUNDATION

13 CLIMATE ACTION

Engineering in High-Altitude Environments

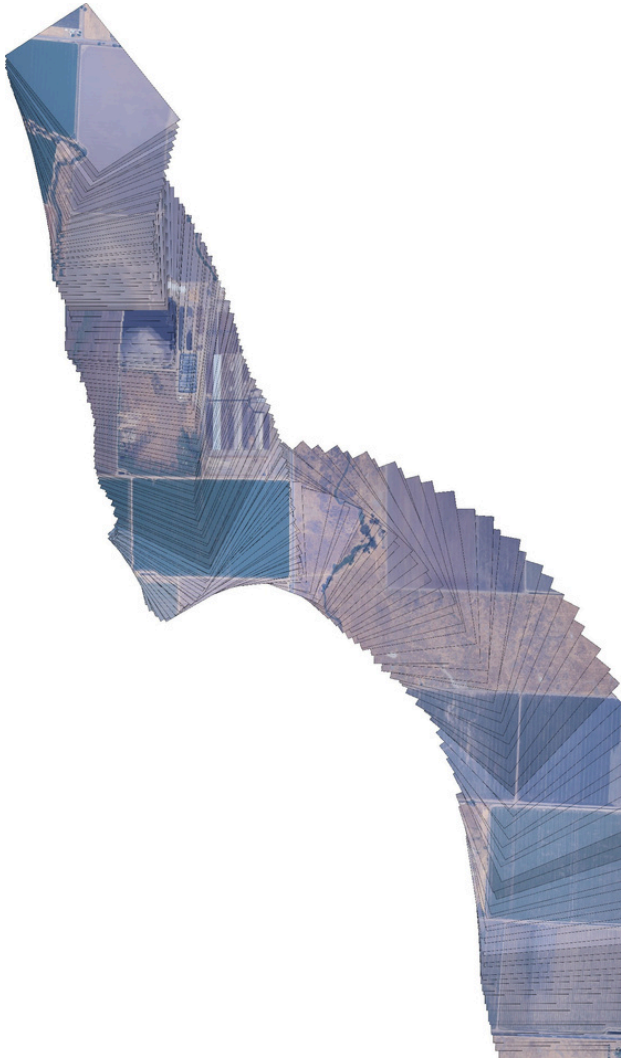
This project involved the processing of variable airborne data collected by a high-altitude platform carrying optical and thermal sensors. The balloon-based platform faced environmental challenges including constant rotations during flight due to wind conditions at high altitudes, resulting in images with inconsistent orientations. The project aimed to simplify the post-processing across various sensors and minimal metadata, to support early wildfire detection efforts.

The work focused on developing a post-processing algorithm to handle images from multiple sensors and generate mosaics. This required implementing feature detection algorithms. The algorithm was designed to handle large datasets efficiently and overcome the unique challenges of building mosaics across diverse landscapes.

The key deliverables included functional Python tools capable of downscaling images to accelerate processing, and generating mosaics from the image galleries. Both tools are critical for efficiently managing and processing large volumes of sensor data.

This algorithm provides the processed data that contributes to an early warning system for wildfire detection, enabling faster responses and potentially reducing the damage caused by wildfires.

Key technology/tools used: Python, GIS mapping



Aerial photo mosaic created with 200 images from the optical sensor.
Attribution: Jhon Félix Vila Solier

Jhon Félix Vila Solier

Peru | Remote Sensing

Jhon is a proactive professional in remote sensing and water resource solutions. He is interested in addressing sustainability, hydrology, and land management challenges toward solving environmental problems.

Managing Fellow
Alex Inoma

Technical Lead Fellow
Chinemerem Iheanacho

Project Partner: good • machine

Balloon Tech Co. is a high-altitude balloon platform providing earth observation data. It focuses on wildfire detection as an early warning system. It is part of **Good Machine**, a venture studio creating solutions for a regenerative world.

Partner Collaborators:

- Beth Van Eman, Project Manager, Good Machine Studio

Project Sponsor: AUTODESK FOUNDATION

13 CLIMATE ACTION

Visual Design to Showcase Electric Aircraft

This project aimed to revamp and the Ampaire website, showcasing the company's cutting-edge electric aircraft technology. Through compelling storytelling, impactful visuals, and modern website design, Ampaire sought to highlight the eco-friendly features of their aircraft, particularly the reduction in carbon emissions, noise pollution, and operational costs. The goal was to communicate the tangible benefits of electric aviation to potential customers and stakeholders.

This project involved close collaboration with the Ampaire team to revamp the initial website hosted on the Wix Studio platform. During the course of the fellowship, Figma was utilized to design mock-ups, showcasing potential layouts for the website. Upon finalizing the mock-ups by the Ampaire design team, the illustrated site pages were implemented within the Wix Studio, including resources, transitions, and ensuring responsiveness of the site.

Additionally, a Direct Operational Cost (DOC) calculator was implemented on the Wix site, ensuring that the fields are appropriately linked to the content management system. This calculator will enable Ampaire customers to seamlessly estimate the prices for trips between airports on the electric aircraft.

The key deliverables included the implementation of the Ampaire website's pages and the DOC calculator using the resources provided. RRThe primary outcome is the launch of a new interactive website that will engage visitors and highlight the features of the eco-friendly electric aircraft.

Key technology/tools used: Wix, Figma and Adobe Illustrator

Ampaire landing page *Attribution: Abhijay Jain*

Project Partner:

AMPAIRE

Project sponsor:

AUTODESK FOUNDATION

Ampaire is making flying more accessible to more people from more airports by developing hybrid-electric aircrafts that are safe, clean, quiet, and less costly.

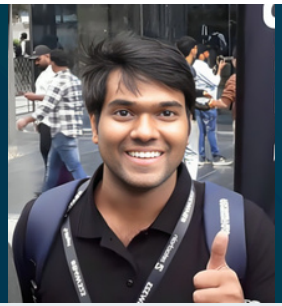
Partner Collaborators:

- Lucenda De Leon, Project Manager

Abhijay Jain

India | **Computer Science**

Managing Fellow
Alex Inoma



Abhijay holds a B-Tech in Computer Science and is pursuing an M.Sc in Cyber Security. He is a full-stack developer and has been engaged with web technologies.

13 CLIMATE ACTION

Developing Climate-Resilient Humanitarian Shelter Designs

Many displaced communities reside in regions plagued by extreme climate risks, which greatly increases their vulnerability. The convergence of displacement with areas prone to climate change, especially flood zones, heightens the threats to their safety and stability. This project aims to tackle these challenges by creating a practical, user-friendly guide for shelter officers, aligned with UNHCR's Strategic Framework for Climate Action (2024-2030).

The focus was on designing shelters that not only withstand climate risks but also provide enduring resilience for displaced populations. Extensive research was conducted on various humanitarian shelter setups, including key case studies such as Dadaab refugee camp in Kenya, which has faced recurring floods for decades, and refugee camps in Idlib and Aleppo, Syria, which are vulnerable to both floods and other extreme weather events.

The project's key deliverables include a comprehensive guideline document on flood-resilient construction techniques, site selections and architectural and structural adaptations.

Three ready-to-use shelter designs and templates were developed using AutoCAD and Revit. They are elevated shelters, shelters on raised platforms, and insulated flood-proof shelters.

By implementing this solution, the project improves safety and living conditions for displaced populations, offering adaptable solutions to better withstand climate-related hazards while promoting sustainability in humanitarian shelter efforts.

Key technology/tools used: Autodesk AutoCAD, Robot Structural Analysis, Revit

3D frame structure of a flood resilient shelter.
Attribution: Hawolul Ali Hussein

Project Partner:

UNHCR The UN Refugee Agency

UNHCR (The United Nations High Commissioner for Refugees) is the UN agency responsible for leading international efforts to protect refugees and internally displaced persons (IDPs), ensuring their rights, safety, and well-being while seeking durable solutions to their challenges.

Project sponsor:

AUTODESK FOUNDATION

Partners Collaborators:

- Rama Al Nimri, Settlement Planning Officer
- Francesca Coloni, Chief Technical Support Lead

Hawolul Ali Hussein

Kenya | Civil and Structural Engineering

Managing Fellow
Ogechi Ogbonna

Technical Lead Fellow
Symon Kiplelgo Kipkemei

Hawolul is a Civil Engineer and Sustainability Champion, utilizing engineering principles to address projects that promote sustainability, conserve the environment, and make a significant impact on contemporary society.

Populating Climate Technology Database for Multiple Technology Types

This project aimed to enhance the integration of emissions modeling data from Koi into Rho Impact's CRANE platform, thereby advancing the efficiency and accuracy of climate technology assessments. CRANE, developed by Rho Impact and Prime Coalition, is a free, open-access tool to evaluate innovative technologies' emissions reduction potential. Koi complements this by transforming authoritative energy and environmental datasets into actionable models, simplifying complex methodologies into decision-useful insights.

The project involved developing a Python-based solution to automate the transformation of Koi's data into CRANE-compatible formats to achieve seamless integration. The process began with extracting essential fields from Koi's dataset to define key parameters for CRANE's input. The script aggregated emissions data by calculating annual values for incumbent and solution scenarios, leveraging interpolated component greenhouse gas values from Koi's dataset, enabling a detailed calculation of emissions reductions over the specified timeframe.

The script addressed uncertainties in the solution scenario to capture potential variability. Market size was calculated by interpolating Koi data, key for assessing market capture potential of climate technologies. Additionally, the script computed the unit impact by comparing baseline and solution emissions, incorporating upper and lower uncertainty bounds to provide a nuanced view of emissions reduction estimates. The final output was a CRANE-compatible JSON file, including transformed data on incumbent unit emissions, solution unit emissions, market size, and unit impact.

The project successfully automated the transformation of Koi data into CRANE format, enabling the rapid and accurate population of the CRANE database with high-resolution emissions models. This significant advancement supports CRANE users in more effectively assessing and reporting on climate technologies.

Key technology/tools used: Google Suite, Python

CRANE and Koi platform logo. *Attribution: Rho Impact*

Wafaa Majzoub

Sudan/Qatar | Chemical Engineering

Managing Fellow
Ogechi Ogbonna

Technical Lead Fellow
Symon Kiplelgo Kipkemei

Wafaa is a chemical engineering professional with an MSc from Texas A&M University; experienced in research, teaching, and leadership. She is passionate about sustainability, circular economy and innovation.

Project Partner:

Rho Impact is built upon over a decade of solving real-world problems with data science, practitioner experience, and software engineering. It uses and contributes to open standards, methodologies, and frameworks to ensure impact forecasts are understandable and comparable.

Partner Collaborators:

- Seth Sheldon, Chief Scientific Officer
- Aurora Ginzburg, Principal Scientist

Project Sponsor:

By Engineers, For Everyone.

Learn more and stay connected with E4C by following our social media channels!

@engineeringforchange

@engineer4change

@engineer4change

Engineering for Change, LLC