

Matthew K. Heun

Professor of Engineering, Calvin University

*Virtual Visiting Research Fellow, University of Leeds, School of Earth and Environment
Extraordinary Professor, Stellenbosch University, School of Public Leadership*

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Areas of Expertise

- Societal Exergy Analysis
- Energy System Economics
- Energy Return on Investment (EROI)
- Lithium-Ion Battery Modeling
- Heat Transfer
- Thermodynamics
- Fluid Dynamics
- Conventional Energy Systems
- Renewable Energy Systems
- Alternative Energy Systems
- Thermal Systems
- Lighter-Than-Air Systems
- Balloons
- Control of Multi-Vehicle Systems

Courses Taught

Calvin University

- ECON 233–The Economics of Energy and Sustainability
- ENGR 181–Engineering Graphical Communication Laboratory
- ENGR 184–Sustainability Challenges
- ENGR 202–Statics and Dynamics
- ENGR 209–Introduction to Conservation Laws and Fluid Mechanics
- ENGR 319–Introduction to Thermal-Fluid Sciences (Thermo., Fluids, & Heat Transfer)
- ENGR 328–Intermediate Thermal/Fluid Sciences and Design
- ENGR 333–Thermal Systems Design (including power systems)
- ENGR 354–Sustainability Engineering
- ENGR 382–Engineering Instrumentation Laboratory
- ENGR 384–Sustainability Analysis
- ENGR 390–Introduction to Aircraft & Aircraft Engine Design (Independent Study)
- ENGR W80–Sustainable Energy Systems
- IDIS 150–Developing the Christian Mind (focus on Global Climate Change)
- IDIS 384–Sustainability Experience
- IDIS W12–The South African Miracle—Challenges and Accomplishments in Politics and Industry

South Africa

- Introduction to Solar Energy, Stellenbosch University, Centre for Renewable and Sustainable Energy Studies
- Conventional Energy Systems, Stellenbosch University, Centre for Renewable and Sustainable Energy Studies
- Wind and Hydro Power, Stellenbosch University, Centre for Renewable and Sustainable Energy Studies
- RAC 441–Refrigeration and Air-Conditioning, Cape Peninsula University of Technology
- Simulation and Optimization of Refrigeration and Air-conditioning Systems, University of Cape Town

Research Interests

- Role of energy in the economy, including economic growth and the rebound effect
- Energy-sustainability interactions in developing world contexts
- Energy Return on Investment (EROI)
- Green Revolving Funds (GRFs)
- Alternative and renewable energy systems including wind, solar, geothermal, and hydro
- Balloon and lighter-than-air vehicle system design and optimization
- Biological analogs for robotic group behavior
- Passive trajectory control for stratospheric balloon systems
- Thermal systems optimization
- Survivable systems for planetary exploration
- Multi-component transient system simulation techniques
- Super-fast numerical equation solvers

Employment and Appointments

- Aug 2002–
present **Professor of Engineering**, *Calvin University*, Grand Rapids, MI
- Full Professor: May 2008
 - Tenured: May 2005
- Jan 2024–
present **Extraordinary Professor**, *Stellenbosch University, Faculty of Economic and Management Science, School for Public Leadership*, Stellenbosch, South Africa
- Apr 2023–
present **Virtual Visiting Research Fellow**, *University of Leeds, Faculty of Environment, School of Earth and Environment*, Leeds, England
- Jun–Aug
2016 **Visiting Scholar**, *Stellenbosch University*, Stellenbosch, South Africa
- Module Lecturer
 - Research Fellow
- Jan–Dec 2009 **Visiting Scholar**, *Stellenbosch University*, Stellenbosch, South Africa
- Module Lecturer
 - Research Fellow
 - Solar Water Heater Project Supervisor
- Jan–Dec 2009 **Visiting Scholar**, *Cape Peninsula Univ. of Technology*, Cape Town, South Africa
- BTech Lecturer
 - MTech Thesis Advisor
 - BTech Capstone Project Supervisor
- Sep 1997–
Sep 2023 **Senior Engineer**, *Global Aerospace Corporation*, Irwindale, CA
- Member of Board of Directors
 - Vice-President of East Coast Operations, Sep 1997–July 2002
- Sep 1995–
Aug 1997 **Member of Technical Staff**, *NASA Jet Propulsion Laboratory*, Pasadena, CA
- Advanced Thermal and Structural Technology Group
- Aug 1989–
Aug 1995 **Graduate Research Assistant**, *University of Illinois*, Urbana-Champaign, IL
- Air-Conditioning and Refrigeration Center (ACRC)
- Sep–Dec 1992 **Short-course Lecturer**, *University of Cape Town*, Cape Town, South Africa
- Taught *Simulation and Optimization of Refrigeration and Air-conditioning Systems*
- Summers
1988, 1989 **Engineering Aide**, *Smiths Industries*, Grand Rapids, MI

Education

- 1991–1995 **Ph.D.**, *University of Illinois*, Urbana-Champaign, IL, Mechanical Engineering
Dissertation: *Performance and Optimization of Microchannel Condensers*
- 1989–1991 **M.S.**, *University of Illinois*, Urbana-Champaign, IL, Mechanical Engineering
Thesis: *Thermal Performance Analysis of an Evaporator-Intercooler Module for a Lorenz Cycle*
- 1985–1989 **B.S.**, *Calvin University*, Grand Rapids, MI, Engineering
Senior Project: *Can Recycling System*

Patents

- Dec 2009 Heun, M.K. and J. Wanner. “Oral Dosing Syringe.” U.S. Provisional Patent #61/266,352.

Grants

- 2024–2025 \$89,000 **Energy Economics** grant for developing online energy and exergy database 1800–2020.
- Fall 2021 **Calvin Research Fellowship** course release for writing *Sustainability Challenges* book.
- January 2019 **Calvin Research Fellowship** course release for editing *Beyond Stewardship* book.
- Summer 2018 \$10,000 **Calvin Center for Christian Scholarship** grant for “Beyond Stewardship” faculty workshop and book project
- 2016 \$4463 **Calvin Alumni Association** grant for sabbatical in Ghana and South Africa
- Spring 2015 Four-year \$85,000 (total) **Major Research Project** award for collaborative sustainability research at Calvin University, 2015–2019
- 2014–15 \$2135 **Calvin Center for Christian Scholarship** working group grant for project entitled “The Metabolic Economy”

- Fall 2012 \$15,000 **Verizon Foundation grant** for Calvin Energy Recovery Fund (CERF)
- 2009 \$5000 **Calvin Alumni Association grant** for sabbatical in South Africa
- April 2005 \$10,000 **National Instruments** software and equipment grant for *Engineering Instrumentation* class to purchase additional LabVIEW® software and FieldPoint™ data acquisition systems

Honors and Awards

- May 2023 **Top Ten Download** award for paper entitled “The Rise and Stall of World Electricity Efficiency: 1900–2017, Results and Implications For the Renewables Transition” (<http://dx.doi.org/10.2139/ssrn.4122765>)
- Apr 2023 **Presidential Award for Exemplary Teaching**, Calvin University. (<https://calvin.edu/offices-services/provost/academic-awards/presidential-award-for-exemplary-teaching/index.html>, <https://calvin.edu/news/archive/on-a-mission-to-inspire-students-to-dream-bigger>)
- Nov 2022 **Top Ten Download** award for working paper entitled “Advancing the Necessary Foundations for Empirical Energy Rebound Estimates: A Partial Equilibrium Analysis Framework.” (<http://dx.doi.org/10.2139/ssrn.4216051>)
- July 2018 **Editor’s choice** award for paper entitled “From Theory to Econometrics to Energy Policy: Cautionary Tales for Policymaking Using Aggregate Production Functions” (<https://doi.org/10.3390/en10020203>)
- Spring 2015 Calvin University **Professor of the Year** (<http://www.calvin.edu/chimes/2015/05/07/class-of-2015-votes-matthew-heun-as-professor-of-the-year/>)
- 9 Feb 2012 Calvin University **Collaborative Change Award** for “leadership in promoting a culture of sustainability” (<https://calvin.edu/offices-services/provost/academic-awards/collaborative-change-award/>)
- 2 Sept 2010 Business Review West Michigan **Greatest Green Initiative Award** for Calvin Energy Recovery Fund (CERF)
- Spring 2009 Calvin University **Professor of the Year** finalist (1 of 10)
- Spring 2004 Awarded **Engineering Professor of the Year** by students on “Engineers Day”
- Spring 1997 JPL NOVA (**Notable Organizational Value Added**) Award for BARBE 2 flight
- 1989–1995 **Shell Aids Fellowship** in Mechanical Engineering, University of Illinois
- 1985–1989 **Honors Scholarship**, Calvin University

Honors and Awards (Former Students)

- Sept 2024 Calvin University summer research students Kenneth Howes and Edom Maru earned **Student Showcase 1st place** at the Consortium for Computing Sciences in Colleges Midwest Region (CCSC–Midwest), 20–21 September 2024, Grand Valley State University, Grand Rapids, MI, USA.
- April 2020 Calvin University graduate John Sherwood named **outstanding graduate teacher of record** at Clemson University, Clemson, South Carolina. <https://www.facebook.com/ClemsonGraduateStudents/posts/3276493859035812>
- May 2016 Calvin University graduate Jordan Hoogendam named **Solar Industry Leader of the Year** by the Canadian Solar Industries Association (CanSIA) at their annual “Game Changer” awards gala in Niagara Falls, Ontario.
- Mar 2015 Calvin University graduate Emmanuel Legbetti named one of *Consulting* magazine’s **Rising Stars of the Profession** (under 35) for his outstanding contributions to clients and the industries in which he serves.
- Nov 2012 Calvin University graduate Eric DeVries awarded **Young Energy Professional of the Year** for Region 3 (Michigan, Indiana, Illinois, Iowa, Ohio, Minnesota and Wisconsin) by the Association of Energy Engineers.
- Dec 2010 Calvin University graduate Laura Rip awarded **Young Energy Engineer of the Year** by the Association of Energy Engineers at its 33rd World Energy Engineering Congress in Washington, DC.

Nov 2009 CPUT BTech student Graham Gariseb (my advisee) awarded **best project** for solar water heater research.

Experience

Software

- PFUSetup An R package to automate the setup process for the PFU database project. R package hosted at <https://github.com/EnergyEconomyDecoupling/PFUSetup>.
- PFUDatabase A **targets** pipeline for developing a societal exergy analysis database using the physical supply-use table framework for energy conversion chain analysis. R package hosted at <https://github.com/EnergyEconomyDecoupling/PFUDatabase>.
- PFUAggDatabase A **targets** pipeline for aggregating societal exergy analysis results. R package hosted at <https://github.com/EnergyEconomyDecoupling/PFUAggDatabase>.
- ReboundTools Analyze energy rebound in R. R package hosted at <https://github.com/MatthewHeun/ReboundTools>.
- IEATools Interact with IEA data in R. R package hosted at <https://github.com/MatthewHeun/IEATools>.
- LMDIR Log-mean divisia index analysis in R. R package hosted at <http://www.github.com/MatthewHeun/lmdir>.
- Recca R energy conversion chain analysis. R package hosted at <https://github.com/MatthewHeun/Recca>.
- matsindf Matrices in R data frames. R package at <https://cran.r-project.org/web/packages/matsindf>.
- matsbyname Matrix mathematics that respects row and column names. R package at <https://cran.r-project.org/web/packages/matsbyname>.
- RCLabels An R package to assist manipulation of matrix row and column labels. R package at <https://cran.r-project.org/web/packages/RCLabels/>. RCLabels was featured as a Top 40 R package for December 2021.

Thesis Examinations

- 16 Nov 2023 Guedes, Rodrigo Miguel Faisca. *Design and development of an interface for historical energy data*. Instituto Superior Tecnico, Lisbon, Portugal.
- 8 Apr 2021 Michalakakis, Charalampos (Harry). *Resource efficiency in the chemical industry*. Cambridge University, Cambridge, England.
- 2 May 2012 Wakeford, Jeremy. *Socioeconomic implications of global oil depletion for South Africa: vulnerabilities, impacts and transition to sustainability*. Stellenbosch University, Stellenbosch, South Africa.

Calvin University (Teaching)

- Fall 2024 Developed class-wide project on designing a **solar PV farm** for Calvin University to support CFO Dirk Pruis. Project was featured twice on Calvin University's News and Stories page and in The Banner. (ENGR 333, PHYS 131, and ENGR 327)
- Fall 2023 Developed innovative class-wide project on selecting a new date for **campus carbon neutrality** to support Calvin University President Wiebe Boer. Project was featured on Calvin University's News and Stories page: <https://calvin.edu/news/archive/students-create-viable-path-for-calvin-university-to-achieve-carbon-neutrality-by-2030>. See student presentation at <https://www.youtube.com/watch?v=kCGY7DX98N8>. (ENGR 333)
- Fall 2022 Developed innovative class-wide project on **reducing carbon emissions** from natural gas heating in collaboration with Calvin University administration. Project was featured on Calvin University's News and Stories page: <https://calvin.edu/news/archive/engineering-students-shifting-carbon-into-neutral-at-calvin-university>. (ENGR 333)
- Fall 2021 Developed class-wide **low-carbon housing** project in collaboration with Habitat for Humanity. Project was featured on Calvin University's News and Stores page: <https://calvin.edu/news/archive/engineering-students-provide-key-insights-for-habitat-for-humanity>. (ENGR 333)
- Jan 2021 Developed innovative class-wide **societal energy analysis** project in collaboration with Leeds University. (ENGR W84)

- Fall 2019 Developed class-wide **energy rebound** project in support of research collaboration with Leeds University. (ENGR 333)
- Fall 2018 Developed innovative **renewable electricity generation** project to support Calvin University physical plant. (ENGR 333)
- Fall 2017 Developed innovative **natural gas savings and co-gen** project to support Calvin University physical plant. (ENGR 333)
- Spring 2017 Developed innovative **bottom-up electricity demand model** project to support Calvin University physical plant. (ENGR 333)
- Fall 2015 Developed innovative **building operations efficiency** project to support Calvin University physical plant. (ENGR 333)
- Jan 2015 Developed innovative **solar PV** design project to support Calvin University. (ENGR W80)
- Fall 2014 Developed innovative **net zero** design project studying nine homes in Grand Rapids, MI. (ENGR 333)
- Jan 2014 Developed innovative **solar PV** design project to support Rehoboth, NM community. (ENGR W83)
- Fall 2013 Developed innovative semester-long student assignment to operate a **biofuel vehicle** using on-campus resources, exclusively. (ENGR 333)
- Fall 2012 Developed innovative semester-long student assignment to design a **geothermal HVAC system** for a new Calvin University building. (ENGR 333)
- Fall 2011 Developed innovative semester-long student assignment to study the **energy efficiency of LEED buildings** using the Calvin University Bunker Interpretive Center as a case study. (ENGR 333)
- June 2011 Developed proposal for a Calvin University **Center for Sustainability Engineering** covering faculty development, courses, and research in the Engineering Department.
- Fall 2008 Developed innovative semester-long student assignment entitled **Calvin Energy Efficiency Fund** wherein students prototyped a Green Revolving Fund aimed at reducing carbon emissions. Fund was implemented by Calvin University in December 2008. (ENGR 333)
- Spring 2008 Developed independent study course on **aircraft engine design** using Mattingly, *Aircraft Engine Design*, AIAA.
- Fall 2007 Developed innovative **Carbon Emissions Trading Simulation (CETS)** where students and professors participated in a simulated carbon trading market for several weeks during a semester. (ENGR 333)
- Fall 2007 Developed innovative semester-long student assignment entitled **Calvin University Carbon Neutrality Project** where students investigated the question “What would it take to make Calvin University carbon neutral?” (ENGR 333)
- 2005, 2007 Developed and co-led January-term overseas class for 18 students entitled “The South African Miracle: Challenges and Accomplishments in Politics and Industry.”
- Spring 2006 Developed independent study course on **aircraft design** using Raymer, *Aircraft Design: A Conceptual Approach*, AIAA.
- Fall 2005 Developed innovative **off-grid** energy independence project for advanced thermal systems class. (ENGR 333)
- Spring 2004 Developed new **air-conditioning laboratory experiments** for intermediate thermal-fluid sciences course. (ENGR 328)
- Spring 2004 Integrated industry-standard National Instruments **LabVIEW** software and **FieldPoint** data acquisition systems into mechanical instrumentation laboratory. (ENGR 382)
- Fall 2002 Upgraded team project assignments to include **real-life thermo-economic analyses** of Calvin University co-generation power plant. (ENGR 333)
- Calvin University (Research)
- 2018–2023 **International collaborator** on University of Leeds project lead by Paul Brockway entitled “Applying thermodynamic laws to the energy-GDP decoupling problem.” I served as the software architect in the effort to build a database of energy and exergy flows through 155 countries.
- July 2023 Member of organizing committee for **International Exergy Economics Workshop**, Challes-les-Eaux, France.

- June 2022 Member of organizing committee for **International Exergy Economics Workshop**, Cambridge, England.
- Summer 2022 Awarded engineering department sustainability research grant for project entitled “**Energy and human well-being.**” Supervised student Ga Mien Le.
- June 2021 Member of organizing committee for **International Exergy Economics Workshop**, Cambridge, England (held virtually, due to coronavirus pandemic).
- Summer 2021 Awarded engineering department sustainability research grant for project entitled “**Useful energy and economic growth** in society.” Supervised students Anjana Sainju and Julian Irtube.
- June 2020 Member of organizing committee for **International Exergy Economics Workshop**, Cambridge, England (held virtually, due to coronavirus pandemic).
- June 2019 Session organizer for European Society for Ecological Economics conference 2019 (ESEE2019): Advances in understanding the **physical structures of economies**: Materials, energy, and the services they provide.
- Summer 2019 Awarded engineering department sustainability research grant for project entitled “Creating a **Primary-Final-Useful Database for Humans and Animals.**” Supervised student Paul Steenwyk to answer the question “How have global intake and conversions of food and feed into useful human and animal work changed since 1800?”
- Summer 2019 Awarded engineering department sustainability research grant for project entitled “**Societal Exergy Analysis for Indonesia.**” Supervised student Michelle Widjanarko to answer the question “Is Indonesia’s current energy-economy trajectory sustainable?”
- Summer 2019 Awarded engineering department sustainability research grant for project entitled “**Societal Exergy Accounting Analysis for South Korea.**” Supervised student James Kim to answer the question “What policies could be implemented to put S. Korea on a more-sustainable energy-economy trajectory?”
- Summer 2018 Awarded engineering department sustainability research grant for project entitled “**Societal Exergy Accounting Analysis for Honduras.**” Supervised student Noah Ver Beek to answer the question “Is Honduras on a sustainable energy-economy trajectory?”
- Summer 2015 Awarded engineering department sustainability research grant for project entitled “**Internet of Things Meets Building Energy Efficiency.**” Supervised student Curtis Kortman to develop a **Raspberry Pi**-based building monitoring system.
- AY 2012–13 Awarded 2-course-release Calvin Research Fellowship (CRF) for project entitled “**Economic development transitions, energy and carbon constraints, and innovation.**”
- 2012 Awarded \$2,462 Calvin Alumni Association research grant for project entitled “Economic development transitions, energy and carbon constraints, and innovation.”
- Summer 2012 Awarded Kuipers Summer Student research fellowship for project entitled “Economic development transitions, energy and carbon constraints, and innovation.” Supervised students Caleb Reese and Lucas Timmer as they gathered data and investigated the **role of energy in economic growth.**
- Summer 2011 Awarded Kuipers Summer Student research fellowship for project entitled “Development of a **Super-fast Numerical Equation Solver** in Java.” Supervised students Tyler Helmus and Caleb Reese as they developed parallelizable numerical equation solving software.
- Spring 2010 Led Renewable Energy Organization (REO) student group to research, select, procure, and install **solar photovoltaic** system at a Lake Michigan location.
- Fall 2008–
Spring 2010 Faculty sponsor and mentor for Elizabeth Huyser’s successful proposal for a prestigious EPA Fellowship on **alternative energy systems.**
- Summer 2008 Awarded Calvin University summer research grant to study **economic performance** of demonstration renewable energy projects on campus. Supervised student researcher (Elizabeth Huyser) to install and maintain renewable energy systems and perform economic analyses.
- Spring 2008 Awarded \$5000 Calvin University Alumni Association grant for Jan–Dec 2009 sabbatical.
- 21 February
2007 Developed dynamic and well-received presentation to Michigan **Governor Jennifer Granholm** on the Calvin University Demonstration Wind Turbine project. See <http://www.calvin.edu/news/releases/2006-07/granholm-visit.htm> for details.

- Spring 2007 Awarded \$6000 Energy Office of the State of Michigan grant to develop and install a **Demonstration Wind Turbine** in the Calvin University Ecosystem Preserve. Successfully managed student Wind Energy Interest Group students and Physical Plant personnel to procure and install the turbine. See <http://wind.calvin.edu> for details.
- March 2007 Awarded \$4000 **software and equipment grant** for the Calvin University Demonstration Wind Turbine project to purchase FieldPoint hardware for instrumenting the demonstration wind turbine.
- Summer 2006 Awarded Calvin University summer research grant to study thermal, comfort, and energy performance of **Earthship houses** in various climates. Supervised student researcher (Neal Kruis) to extend EnergyPlus modeling software and perform field experiments.
- Summer 2005 Awarded summer research grant to study refrigeration technology and electrification patterns in South Africa. Supervised student researcher (Kayt Vincent) to extend exergy analysis techniques to refrigeration systems to **improve economic viability of refrigerators** for rural, newly-electrified regions of South Africa.
- Summer 2004 Awarded \$6000 Energy Office of the State of Michigan grant to develop and install a demonstration **solar thermal hot water snow melt** system for the roof of DeVries Hall. Supervised student Andrew Van Noord.
- AY 2003–04 Served as mentor for **Active Cavity Radiometer (ACR)** Senior Design Project. Supported students designing a device for studying global warming. Students presented work at a NASA Institute for Advanced Concepts (NIAC) Fellows Meeting, April 2004.
- Summer 2003 Evaluated options for solar power systems for **Mars Microsatellites** under a NASA Jet Propulsion Laboratory (JPL) contract. Supervised students Sam Schoofs and Paul Sokomba.
- Summer 2003 Awarded Calvin University summer research grant to study **co-generation of electrical and thermal energy** from solar array systems. Research performed with student Jordan Hoogendam.
Calvin University and Community (Service)
- Summer 2023 Co-developed and co-led (with colleagues Debra Rienstra, David Smith, David Koetje, Jamie Skillen, and David Wunder) innovative **Pedagogy of Sustainability** faculty development workshop.
- 2022–2023 Member of Calvin University **Community of Practice (COP)** on Sustainability. Developed new campus-wide **Sustainability Designation** and departmental **Energy, Environment, and Sustainability Engineering (EESE)** concentration.
- 2018–2022 Chair of Calvin University **environmental and energy stewardship** committee.
- 2017–Present Chair of Calvin University engineering department **facilities and finance** committee.
- 2019–2021 Member of board of directors for **West Michigan Environmental Action Council (WMEAC)**.
- 2017–2020 Calvin University **faculty senator**.
- 2010–2019 **Calvin Energy Recovery Fund (CERF)** manager.
- Summer 2017 Co-developed and co-led (with colleagues Gail Heffner and Clarence Joldersma) innovative **Global Warming** faculty development workshop.
- 2008–2014 Member of **City of Grand Rapids Renewable Energy Team** at the request of Mayor George Heartwell.
- Summers 2010 & 2012 Co-developed and co-led (with colleagues Gail Heffner and Clarence Joldersma) innovative **Sustainability Across the Curriculum** faculty development workshop.
- May 2011, 2009, 2008 Co-developed and co-led (with colleagues Gail Heffner and Clarence Joldersma) Calvin University **Sustainability Summit**.
- Spring 2010 Worked with faculty Environmental Stewardship Committee (ESC) to implement policies and guidelines for the Calvin Energy Recovery Fund (CERF).
- Fall 2008 Served as Interim **Director for Sustainability** responsible for developing strategies to reduce CO₂ emissions and developing the **Calvin Sustainability Scorecard (CSS)**.
- Fall 2008 Developed innovative, multidisciplinary half-day seminar on **climate change** for Christian Reformed World Relief Committee (CRWRC) with colleague David Warners (Biology).
- 2005–present Faculty advisor for **Renewable Energy Organization (REO)**, a student club that promotes renewable energy both on campus and in the broader community.

2006–2008 Chair of Calvin University Committee on Scholarships and Financial Aid.

Global Aerospace Corporation

- Analyzed innovative balloon inflation system for **Upward Falling Payload (UFP)** project with detailed, transient thermodynamics and heat transfer model, including finite difference conduction in two materials and dozens of ordinary differential equations. (Spring 2015)
- Developed innovative **numerical equation solver** based on SuperSolver code base.
- **Software architect** for new software package for modeling Lithium-Ion battery performance under STTR funding with NASA’s Jet Propulsion Laboratory as partner.
- Successfully developed, proposed, and won Phase I NSF SBIR contract to develop a **low-cost Radiosonde-Radiometer (RadSonde)** to measure atmospheric radiation to 30 km altitude.
- Successfully conceived, proposed, and won Phase I and Phase II NASA SBIR contracts to develop and deliver (Dec. 2004) next-generation **balloon design and performance modeling software** called Navajo.
- Principle Investigator for **Navajo Phases I and II** before moving to Calvin University.
- Developed improved scientific balloon **radiative/convective thermal and dynamic balloon trajectory performance models** for Navajo.
- Analyzed thermal characteristics of **advanced solar array power systems** for stratospheric balloons.
- Evaluated Earth science potential for stratospheric platforms (**balloons, airships, and UAVs**).
- Extended existing **airship design model** to include future advanced technologies, including solar arrays, fuel cells, and hull materials.
- Developed predictions of **future airship performance and design** using advanced airship design model.
- Performed first-of-their-kind **simulations of stratospheric balloon network control** (hundreds of balloons) and configuration evolution. Simulations indicated feasibility of a global balloon network concept.
- Developed and implemented new, **advanced algorithms for stratospheric balloon constellation control**. Used algorithms to develop application-specific simulations of balloon constellations, including global meteorological disaster monitoring and “adaptive” meteorological observations.
- Performed thermal analysis in support of **advanced stratospheric pumpkin balloon** design activities. The analyses helped identify new material options for NASA pumpkin balloons.
- Principal Investigator for **Balloon Latitude Trajectory Control System**, for NASA Phase I and Phase II SBIR awards.
- Managed the successful prototyping and full-scale fabrication of advanced technology for balloon trajectory control using novel suspended wing device.
- Conceived, proposed, developed, and delivered the **Trajectory Simulation and Prediction System (TSPS)** to NASA’s scientific balloon program. The system assists operators with safety and flight termination decisions.
- **Managed NASA subcontract** through Computer Sciences Corporation (CSC) to continue development of the TSPS for NASA’s Ultra-Long Duration Balloon (ULDB) Program.
- Managed Global Aerospace Corporation’s East Coast Office.

Extol, Inc.

Fall 2006 Assisted thermal design process for new hot-plate welder.

August 2005 Made presentation to Extol management entitled “Advanced Hot Plate Welding: Experiments and Analysis.”

Summer 2005 Successfully developed thermal model of hot-plate welder that predicted thermal variations to ± 3 °F.

Jet Propulsion Laboratory

- Performed laboratory thermal performance testing (conduction and convection) of 20–80 K prototype Earth Observing Satellite (EOS) cryocoolers. The testing characterized performance and allowed comparative analysis of cryocoolers from several manufacturers.
- Performed vibration testing of prototype EOS cryocoolers. The vibration testing enabled the design of launch systems that avoid cryocooler resonances.

- Performed satellite radiative thermal analysis that enabled the design of sun shields on cryocooler enclosures.
- Developed test fixtures for cryocooler laboratory thermo-mechanical performance analysis.
- Developed Mars Balloon Thermal (and trajectory) Model (MBTM) for Mars Aerobot Balloon System (MABS) study. The model enabled mission planning for a proposed 2005 Mars mission.
- Developed thermal performance model for Jupiter Infrared Montgolfiere Aerobot (IRMA). The model was used to design atmospheric entry sequences.
- Refined thermal performance models for Earth, Venus, and Titan aerobots. The refined models improved the accuracy of trajectory predictions for prototype flights at Earth.
- Represented aerobot technology to NASA's New Millennium Program Integrated Product Development Team.
- Flight Director for successful BARBE 2 and ALICE 8 aerobot prototype test flights. The flights demonstrated the feasibility of Phase-Change Fluid (PCF) balloon systems for exploration at Venus and Titan.
- Led Venus Geoscience Aerobot balloon system study effort (VEGAS) which performed preliminary design of Venus balloon and spacecraft systems.
- Led survivable Venus aerobot gondola development effort which developed concepts for protection of science instruments at Venus surface conditions (460 °C, 92 atm).
- Led buoyancy control system hardware development for Earth-based aerobots (PAT).

University of Illinois

- Designed, built, and operated calorimeter test facility for advanced automotive air-conditioning microchannel heat exchangers that provide increased energy efficiency.
- Developed microchannel condenser thermal design optimization techniques that led to more energy-efficient condenser designs.
- Developed heat exchanger designs for household refrigerators using zeotropic refrigerant mixtures. These designs were aimed at practical use of non ozone-depleting refrigerants.
- Acquired strong thermal systems modeling background.

Africa

- 2016 Sabbatical at Stellenbosch University's Centre for Renewable and Sustainable Energy Studies (CRSES).
- June 2012 Taught solar thermal portion of Introduction to Solar Energy at Stellenbosch University.
- 2009 Established and led the Sustainability Think Tank (STT) at Stellenbosch University. STT is an organized group of faculty, staff, and students interested in advancing sustainability issues on campus.
- 2009 Developed proposal for the Stellenbosch University South African Renewable Energy Training, Research, and Education Centre. This work led to the establishment of SARETEC.
- 2009 Developed economic and technical scenarios for analysis of a Concentrated Solar Power (CSP) plant for South Africa.
- 2009 Served as a consultant for establishing a Sustainability Scorecard for Stellenbosch University.
- 2009 Sabbatical at Cape Peninsula University of Technology (CPUT) and Stellenbosch University's Centre for Renewable and Sustainable Energy Studies (CRSES).
- Jan 2005 Co-led Calvin University interim (January term) class to South Africa to study political and industrial & 2007 change.
- 1992 Organized, developed, promoted, and taught Simulation and Optimization of Refrigeration and Air-conditioning Systems short-course at the University of Cape Town and the University of Witwatersrand, South Africa.

Computer Skills

Languages	Applications	Development	Platforms
<ul style="list-style-type: none"> • R • L^AT_EX • Java • Fortran • BASIC • HTML 	<ul style="list-style-type: none"> • Microsoft Office • EES • LabVIEW • Aperture • various blogging platforms 	<ul style="list-style-type: none"> • RStudio • Eclipse • TextMate • GitHub • CVS • ANT 	<ul style="list-style-type: none"> • Macintosh • UNIX • Windows • Linux

Web Links

- GitHub repositories
<http://www.github.com/MatthewHeun>
<http://www.github.com/EnergyEconomyDecoupling>
- Beyond Stewardship
<http://www.beyondstewardship.com>
- Exergy Economics
<https://exeryeconomics.wordpress.com>
- Beyond GDP
<http://www.springer.com/energy/policy%2C+economics%2C+management+%26+transport/book/978-3-319-12819-1>
- Calvin University page
<http://www.calvin.edu/~mkh2>
- Greatest Green Initiative: CERF
http://www.mlive.com/business/west-michigan/index.ssf/2010/09/green_awards_2010_calvin_colle.html
- South African Renewable Energy Technology Centre
<https://www.saretec.org.za>
<https://www.io1.co.za/capetimes/news/renewable-energy-technology-centre-at-cput-supplying-key-skills-18200210>
- Calvin University Demonstration Wind Turbine
<http://wind.calvin.edu>
- Calvin University January-term class
http://www.calvin.edu/weblogs/south_africa_interim
- Calvin University Engineering
<http://enr.calvin.edu>
- Calvin University Course Catalog
<https://catalog.calvin.edu>
- Global Aerospace Corporation
<http://www.gaerospace.com>
- Trajectory Simulation
http://gaerospace.com/projects/ULBDTrajectory/ULDB_traj_sim.html
- Global Balloon Network
http://gaerospace.com/projects/StratoCon/global_constellation.html
- JPL Aerobot Program
<http://web.archive.org/web/19980223143125/http://telerobotics.jpl.nasa.gov/aerobot/>

Publications, presentations, and professional activities

Books

Van Antwerp, Jeremy and Matthew Kuperus Heun (May 6, 2022). *A Framework for Sustainability Thinking: A student's introduction to global sustainability challenges*. Synthesis Lectures on Sustainable Development 4. Morgan & Claypool. DOI: 10.2200/S01168ED1V01Y202202SDE004.

Warners, David Paul and Matthew Kuperus Heun (Aug. 8, 2019). *Beyond Stewardship: New approaches to creation care*. The Calvin Press. URL: <https://calvin.edu/directory/publications/beyond-stewardship>.

Heun, Matthew Kuperus, Michael Carbajales-Dale, and Becky Roselius Haney (May 11, 2015). *Beyond GDP: National Accounting in the Age of Resource Depletion*. Vol. 26. Lecture Notes in Energy. Springer International Publishing. ISBN: 978-3-319-12820-7. DOI: 10.1007/978-3-319-12820-7.

Book chapters

Heun, Matthew Kuperus (Aug. 8, 2019). *Smashing Prototypes. Chapter 1 in Beyond Stewardship: New approaches to creation care*, David Paul Warners and Matthew Kuperus Heun eds, 23–30. Calvin Press, Grand Rapids, Michigan. URL: <https://calvin.edu/directory/publications/beyond-stewardship>.

Journal articles

- Aramendia, Emmanuel, Paul E. Brockway, Peter G. Taylor, Jonathan B. Norman, Matthew K. Heun, and Zeke Marshall (May 20, 2024). “Estimation of useful-stage energy returns on investment for fossil fuels and implications for renewable energy systems”. *Nature Energy* 9, pp. 1–21. DOI: 10.1038/s41560-024-01518-6.
- Brockway, Paul E, Matthew Kuperus Heun, Zeke Marshall, Emmanuel Aramendia, Paul Steenwyk, Thomas Relph, Michelle Widjanarko, Jeonghoo (James) Kim, Anjana Sainju, and Julian Irtube (June 17, 2024). “A country-level primary-final-useful (CL-PFU) energy and exergy database: Overview of its construction and 1971–2020 world-level efficiency results”. *Environmental Research: Energy* 1(025005), pp. 1–29. DOI: 10.1088/2753-3751/ad4e39.
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- Steenwyk, Paul, Matthew Kuperus Heun, Paul Brockway, Tânia Sousa, and Sofia Henriques (Feb. 14, 2022). “The Contributions of Muscle and Machine Work to Land and Labor Productivity in World Agriculture Since 1800”. *Biophysical Economics and Sustainability* 7(2), pp. 1–17. DOI: 10.1007/s41247-022-00096-z.
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- Brockway, Paul E., Steve Sorrell, and Matthew Kuperus Heun (July 2021). “Save More; Spend More—getting to grips with the rebound effect”. *The Environment: The magazine for the Chartered Institution of Water and Environmental Management*, pp. 14–16.
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- Roberts, Ryan, Josephine Kaviti Musango, Alan Colin Brent, and Matthew Kuperus Heun (Sept. 12, 2018). “The Correlation between Energy Cost Share, Human, and Economic Development: Using Time Series Data from Australasia, Europe, North America, and the BRICS Nations”. *Energies* 11(2405), pp. 1–15. DOI: 10.3390/en11092405.
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- Heun, Matthew Kuperus, Michael Carbajales-Dale, and Becky Roselius Haney (Oct. 1, 2015). *Time to replace the GDP with a measure that accounts for natural resources*. Upstate Business Journal, Greenville, South Carolina. URL: <http://upstatebusinessjournal.com/innovate/time-to-replace-the-gdp-with-a-measure-that-accounts-for-natural-resources/>.
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- Smith, Mark K., Matthew Kuperus Heun, Roy R. Crawford, and Ty A. Newell (July 1990). “Thermodynamic Performance Limit Considerations for Dual-evaporator, Non-azeotropic Refrigerant Mixture-based Domestic Refrigerator-Freezer Systems”. *International Journal of Refrigeration* 13, pp. 237–242. DOI: 10.1016/0140-7007(90)90035-U.

Data repositories

- Brockway, Paul, Zeke Marshall, Matthew K Heun, Emmanuel Aramendia, and Paul Steenwyk (June 17, 2024). *Dataset associated with the paper: A Country-Level Primary-Final-Useful (CL-PFU) Energy and Exergy Database: Overview of its construction and 1971–2020 world-level efficiency results. [Dataset]*. Dataset housed at University of Leeds Data Repository. DOI: 10.5518/1536.
- Marshall, Zeke, Paul E. Brockway, Matthew Kuperus Heun, Emmanuel Aramendia, Paul Steenwyk, Thomas Relph, Michelle Widjanarko, Jeonghoo Kim, Anjana Sainju, and Julian Iturbe Franzius (June 3, 2024). *A Country-Level Primary-Final-Useful (CL-PFU) energy and exergy database v1.2, 1960–2020*. Dataset housed at University of Leeds Data Repository. DOI: 10.5518/1536.
- Brockway, Paul E., Matthew Kuperus Heun, and Gregor Semieniuk (Oct. 25, 2022). *Calculation data sheets for the rebound case study examples used in the journal working paper “Advancing the necessary foundations for empirical energy rebound estimates: A partial equilibrium analysis framework”*. <https://doi.org/10.5518/1201>. DOI: 10.5518/1201.
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- Ver Beek, Noah, Elvin Vindel, Matthew Kuperus Heun, and Paul E. Brockway (June 19, 2020). *Data associated with “Quantifying the Environmental Impacts of Cookstove Transitions: A Societal Exergy Analysis Based Model of Energy Consumption and Forest Stocks in Honduras.” University of Leeds*. <https://doi.org/10.5518/828>. DOI: 10.5518/828.
- Brockway, Paul E. and Matthew Kuperus Heun (Jan. 9, 2017). *Data associated with “Energy rebound as a potential threat to a low-carbon future: Findings from a new exergy-based national-level rebound approach.” University of Leeds*. <https://doi.org/10.5518/137>. DOI: 10.5518/137.

Heun, Matthew K., João Santos, Paul E. Brockway, Randall J. Pruijm, Tiago Domingos, and Marco Sakai (Feb. 10, 2017). *Data associated with “From Theory to Econometrics to Energy Policy: Cautionary Tales for Policymaking Using Aggregate Production Functions.”* University of Leeds. <https://doi.org/10.5518/152>. DOI: 10.5518/152.

Working papers

Heun, Matthew Kuperus, Gregor Semieniuk, and Paul E. Brockway (Sept. 12, 2022). *Advancing the Necessary Foundations for Empirical Energy Rebound Estimates: A Partial Equilibrium Analysis Framework*. USAEE Working Paper 22-563. Social Science Research Network (SSRN). DOI: 10.2139/ssrn.4216051.

Heun, Matthew K., Anne Owen, and Paul E. Brockway (Nov. 13, 2017). *A physical supply-use table framework for energy analysis on the energy conversion chain*. Sustainability Research Institute Paper 111. University of Leeds, School of Earth and Environment, Sustainability Research Institute. URL: <http://www.see.leeds.ac.uk/fileadmin/Documents/research/sri/workingpapers/sri-wp111.pdf>.

de Wit, Martin, Matthew Kuperus Heun, and Douglas Crookes (Feb. 2013). *An Overview of Salient Factors, Relationships and Values to Support Integrated Energy-Economic Systems Dynamic Modelling*. Working Paper 02/13. Department of Economics and the Bureau for Economic Research at the University of Stellenbosch. URL: <http://www.ekon.sun.ac.za/wpapers/2013/wp022013/wp-02-2013.pdf>.

Invited presentations

Heun, Matthew Kuperus and Paul Brockway (Jan. 9, 2025). *CL-PFU and WLR-PFU databases*. Presentation to Jared Wollacott (EIA) at Montreaux Society Macroeconomics Modeling Workshop, London.

Heun, Matthew Kuperus and Paul E. Brockway (Mar. 4, 2025). “A Country-Level Primary, Final, Useful Energy and Exergy Database to Improve Understanding of Energy and the Economy”. Presentation to Energy Symposium, University of Texas at Austin.

Aramendia, Emmanuel, Paul E. Brockway, Matthew Kuperus Heun, and Zeke Marshall (Apr. 2024). *A primary-final-useful energy and exergy database to inform post-growth modelling and policies*. Online Presentation to Models, Assessment, and Policies for Sustainability (MAPS) personnel at Universitat de Barcelona, Spain.

Aramendia, Emmanuel, Paul E. Brockway, Matthew Kuperus Heun, and Zeke Marshall (Mar. 18, 2024). *A primary-final-useful energy and exergy database to inform post-growth modelling and policies?* Online Presentation to Institut de Ciència i Tecnologia Ambientals (ICTA-UAB).

Heun, Matthew Kuperus (July 18, 2024). *Country-level primary-final-useful (CL-PFU) and world long-run (WLR-PFU) energy and exergy databases*. Presentation at bi-monthly Exergy Economics research network call.

Heun, Matthew Kuperus (Nov. 6, 2024). *Green Revolving Funds: When Financial Incentives and Good Intentions Align*. Invited presentation to microeconomics course for Albert M. Wolters Center for Christian Scholarship Lecture Series 2024–2025. Redeemer University.

Heun, Matthew Kuperus, Paul Steenwyk, Michelle Widjanarko, Jeonghoo (James) Kim, Anjana Sainju, Julian Irtube, Paul E. Brockway, Zeke Marshall, Emmanuel Aramendia, and Thomas Relph (Apr. 15, 2024). *Country-level primary-final-useful (CL-PFU) Database: Built using a Physical Supply Use Table (PSUT) Framework*. Online Presentation to the United Nations International Energy Agency (IEA).

Heun, Matthew Kuperus, Paul Steenwyk, Michelle Widjanarko, Jeonghoo (James) Kim, Anjana Sainju, Julian Irtube, Tâina Sousa, Ricardo Pinto, Bernardo Tostes, Sofia T. Henriques, Nigazh Indirani, Rodrigo Guedes, Paul E. Brockway, Zeke Marshall, Emmanuel Aramendia, and Thomas Relph (June 25, 2024). *Country-level primary-final-useful (CL-PFU) and world long-run (WLR-PFU) energy and exergy databases*. IREES (Integrated Research on Energy, Environment, and Society) Colloquium, University of Groningen, Netherlands.

Heun, Matthew Kuperus and David P. Warners (Nov. 6, 2024). *Teaching and learning for sustainability*. Workshop for faculty for Albert M. Wolters Center for Christian Scholarship Lecture Series 2024–2025. Redeemer University.

Warners, David P. and Matthew Kuperus Heun (Nov. 5, 2024). *Beyond Stewardship: New approaches to creation care*. Keynote presentation for Albert M. Wolters Center for Christian Scholarship Lecture Series 2024–2025. Redeemer University. <https://www.youtube.com/watch?v=S0m42-Mos7Q>.

Warners, David P. and Matthew Kuperus Heun (Nov. 5, 2024). *Institutional commitments and structures for a sustainable campus*. Workshop for administrators and staff for Albert M. Wolters Center for Christian Scholarship Lecture Series 2024–2025. Redeemer University.

Warners, David P. and Matthew Kuperus Heun (Nov. 6, 2024). *Walking through a world of gifts*. Chapel address during Albert M. Wolters Center for Christian Scholarship Lecture Series 2024–2025. Redeemer University.

- Heun, Matthew Kuperus (June 6, 2022). “Energy Rebound”. Presentation to students in Selected topics of energy and environmental economics, Tecnológico de Monterrey, Mexico.
- Heun, Matthew Kuperus (Sept. 15, 2022). *Physical Supply-Use Table (PSUT) Framework for ECC Analysis*. Presentation to University of Grenoble.
- Sousa, Tania, Sofia Henriques, Paul Brockway, Matt Heun, Tiago Domingos, Ricardo Pinto, and Laura Felicio (Nov. 23, 2021). *The how and why of electricity use: Additional insights from Portugal and a World long-run time series on electricity since 1900*. Presentation at University of Texas Energy Seminar. URL: <https://energy.utexas.edu/events/146>.
- Warners, David Paul and Matthew Kuperus Heun (Oct. 22, 2019). *Beyond Stewardship: New approaches to creation care*. Presentation at Town Hall event, Calvin Seminary.
- Heun, Matthew K. (Nov. 9, 2017). “From Theory to Econometrics to Energy Policy: Cautionary Tales for Policymaking Using Aggregate Production Functions”. Presentation to Energy Symposium, University of Texas at Austin. URL: <https://mediasite.aces.utexas.edu/UTMediasite/Play/16c72ebaac03488d828ec0df2953eb511d?catalog=132651a4-ec47-440e-ba27-334ffd9889f0>.
- Heun, Matthew Kuperus (May 17, 2017). “Energy and the Macroeconomy: Five Propositions”. Invited Lecture (via Skype) to Renewable Energy Policy Module at the Centre for Renewable and Sustainable Energy Studies, Stellenbosch University, Stellenbosch, South Africa.
- Heun, Matthew Kuperus (Apr. 27, 2017). “Energy conversion chain (ECC) analysis: A proposed unifying physical supply-use table framework”. Presentation to international colleagues (Cambridge University and Clemson University) via Skype, Calvin College, Grand Rapids, MI, USA.
- Heun, Matthew Kuperus (Aug. 19, 2016). “Energy and the Macroeconomy: Five Propositions”. Presentation to the University of Stellenbosch Centre for Renewable and Sustainable Energy Studies (CRSES) Forum, Sustainability Institute, Lynedoch, Stellenbosch, South Africa.
- Heun, Matthew Kuperus (May 19, 2016). “From Theory to Econometrics to Policy: Cautionary tales for policymaking with the CES aggregate production function”. Invited Lecture (via Skype) to Renewable Energy Policy Module at the Centre for Renewable and Sustainable Energy Studies, Stellenbosch University, Lynedoch, Western Cape, South Africa.
- Heun, Matthew Kuperus (Aug. 22, 2016). “Useful Exergy in Ghana and South Africa”. Presentation to Mechanical and Mechatronic Engineering Research Lecture Series, University of Stellenbosch, Western Cape, South Africa.
- Heun, Matthew Kuperus (Mar. 31, 2015). “Energy in Macroeconomic Growth Modeling”. Invited presentation to Net Energy Analysis Workshop, Stanford University.
- Heun, Matthew Kuperus (Nov. 6, 2015). “Green Revolving Funds: When Financial Incentives and Good Intentions Align”. Presentation at Climate Action Plan Workshop, Western Michigan University, Kalamazoo, Michigan.
- Heun, Matthew Kuperus (Sept. 4, 2015). “Green Revolving Funds: When Financial Incentives and Good Intentions Align”. Presentation to Clemson University Facilities Department, Clemson University, Clemson, South Carolina.
- Heun, Matthew Kuperus (May 20, 2015). “Green Revolving Funds: When Financial Incentives and Good Intentions Align”. Invited Lecture (via Skype) to Energy Policy Module at the Centre for Renewable and Sustainable Energy Studies, Stellenbosch University, Lynedoch, Western Cape, South Africa.
- Heun, Matthew Kuperus (Jan. 23, 2015). “Saving Energy and Money with Green Revolving Funds”. Presentation to Economicology Forum at Aquinas College, Grand Rapids, Michigan.
- Heun, Matthew Kuperus (Jan. 9, 2015). “Saving Energy and Money with Green Revolving Funds”. Presentation to West Michigan Sustainable Business Forum meeting at Calvin College, Grand Rapids, Michigan.
- Heun, Matthew Kuperus (May 7, 2015). “When Financial Incentives and Good Intentions Align: Celebrating Six Years of the Calvin Energy Recovery Fund”. Keynote presentation to Calvin Environmental Assessment Program Poster Session at Calvin College, Grand Rapids, Michigan.
- Heun, Matthew Kuperus, Michael Carbajales-Dale, and Becky Roselius Haney (Nov. 4, 2015). “Beyond GDP: National Accounting in the Age of Resource Depletion”. Presentation at Environmental Engineering and Earth Sciences (EEES) Department Seminar Clemson University, Clemson, South Carolina.
- Heun, Matthew Kuperus (Jan. 9, 2014). “Energy Efficiency and Green Revolving Funds”. Presentation to Muskegon Area Sustainability Coalition Energy Efficiency Briefing.

- Heun, Matthew Kuperus (Oct. 23, 2014). “Running the Engine: How Energy Propels the Economy”. Invited presentation to the World Affairs Council of West Michigan Fall Lecture Series “The Future of Energy.” Losemoore Auditorium, Grand Valley State University.
- Heun, Matthew Kuperus (Apr. 18, 2014). “Saving both Money and Energy with Green Revolving Funds”. Presentation to US Green Building Council of West Michigan.
- Heun, Matthew Kuperus (Oct. 15, 2013). “Energy Efficiency and Green Revolving Funds”. Invited presentation at West Michigan Energy Leaders: A forum for strategic energy projects for West Michigan.
- Heun, Matthew Kuperus (Oct. 25, 2013). “Energy Efficiency and Green Revolving Funds”. Presentation to Grand Rapids Public Schools Sustainability Subcommittee.
- Heun, Matthew Kuperus (Apr. 16, 2013). “What Does Creativity Have to do with Engineering, Science, and Math?” Presentation to St. Thomas the Apostle School 7th Grade science classes.
- de Wit, Martin, Jeremy Wakeford, and Matthew Kuperus Heun (June 13, 2012). “The Socio-Economic Impacts of Energy Resource Scarcity in South Africa and the World”. Presentation to University of Stellenbosch Centre for Renewable and Sustainable Energy Studies Discussion Forum, Lymedoch, South Africa.
- Heun, Matthew Kuperus (Apr. 28, 2012). “Our Energy Future: Why it Matters”. Presentation to Calvin College Alumni Association, Pella, Iowa.
- Heun, Matthew Kuperus (July 21, 2009). “Campus Sustainability”. Presentation to the Leadership Forum of the University of Stellenbosch Health Sciences Faculty, Tygerberg Campus, University of Stellenbosch, Tygerberg, South Africa.
- Heun, Matthew Kuperus (July 27, 2009). “Campus Sustainability: An Example from Calvin College”. Invited presentation at the University of Cape Town Service Learning Discussion Forum, University of Cape Town, South Africa.
- Heun, Matthew Kuperus (Aug. 18, 2009). “Green Campuses”. Keynote presentation given to the Sustainability Summit of the University of Stellenbosch Health Sciences Faculty, Tygerberg Campus, University of Stellenbosch, South Africa.
- Heun, Matthew Kuperus and John Critien (May 8, 2009). “Green Campuses”. Presentation given at the Centre for Renewable and Sustainable Energy Studies Forum. University of Stellenbosch, Stellenbosch, South Africa.
- Heun, Matthew Kuperus and John Critien (May 22, 2009). “Green Campuses”. Presentation given at the Green Campus Forum, University of Cape Town, Cape Town, South Africa.
- Heun, Matthew Kuperus (Jan. 31, 2008). “Climate Change and Renewable Energy”. Presentation for Focus the Nation, Calvin College, Grand Rapids, Michigan.
- Heun, Matthew Kuperus (May 21, 2008). “Context and Goal-Setting: How Climate Change Could Affect Calvin”. Presentation to Calvin College Sustainability Summit, Calvin College, Grand Rapids, Michigan.
- Heun, Matthew Kuperus, David W. Wunder, Corinne Kluge, Valerie Horstmann, and Betsy Huyser (May 8, 2008). “Shared Learning—Student Research in Engineering”. Presentation to Calvin College Regional Councils.
- Heun, Matthew Kuperus (Nov. 29, 2007). “Energy and Emissions, Calvin and Carbon: Where are We Heading? Where are You Heading?” Presentation to Calvin Environmental Assessment Program (CEAP) Poster Session.
- Heun, Matthew Kuperus (Apr. 10, 2007). “From Seed to Fruit: One Professor’s View of the Importance of Faculty Scholarship”. Presentation to Calvin College Knollcrest Circle Annual Dinner, Calvin College, Grand Rapids, Michigan.
- Heun, Matthew Kuperus (Aug. 24, 2005). “Advanced Hot Plate Welding: Experiments and Analysis”. Proprietary presentation to Extol, Inc. Product Development Group, Zeeland, Michigan.
- Heun, Matthew Kuperus (Jan. 16, 2004). “The Utility of Statistics for Atmospheric Science from StratoSat Platforms”. Seminar presented to Western Michigan University Statistics Department Colloquium, Kalamazoo, Michigan.

Conference papers

- Aaron, Kim M., Matthew Kuperus Heun, and Kerry T. Nock (June 28, 2009). “Balloon Trajectory Control”. *A Collection of the 13th AIAA Lighter-than-Air Systems Technology Conference and AIAA International Balloon Technology Conference Technical Papers*. AIAA-99-3865, pp. 115–121.
- Van Antwerp, Jeremy, Julie Anne Field Wildschut, and Matthew Kuperus Heun (June 25, 2023). “Sustainability designation, introductory course, and a new textbook in an engineering curriculum”. *2023 ASEE Annual Conference & Exposition*. 44384. ASEE Conferences. URL: <https://peer.asee.org/44384>.

- Van Antwerp, Jeremy and Matthew Kuperus Heun (July 12, 2019). “Current disciplines and worldviews are insufficient to address sustainability challenges”. Paper presented at Christian Engineering Conference, Dordt College, Sioux Center, IA.
- Dippenaar, Josh, Alan Brent, Josephine Kaviti Musango, Matthew Kuerpus Heun, and William Stafford (June 14, 2018). “Investigating the city-level correlation between energy consumption and economic growth: A review and way forward”. Paper presented at 24th International Sustainable Development Research Society Conference, University of Messina, Messina, Italy.
- Heun, Matthew Kuperus (Mar. 30, 2016). “Engineering and faith commitments: A reformed Christian’s perspective”. Paper presented at the 47th Ghana Institution of Engineers (GhIE) Annual Conference, Accra, Ghana.
- Santos, João, Matthew Kuperus Heun, Paul Brockway, Marco Sakai, and Tiago Domingos (July 2, 2015). “Aggregate production functions: How does the Solow Residual change when introducing quality-adjusted values for capital, labour, and energy?” Unpublished paper prepared for the 11th Biennial Conference of the European Society for Ecological Economics (ESEE2015), University of Leeds, Leeds, England.
- Halpert, Gerald, Matthew Kuperus Heun, and Kerry T. Nock (June 14, 2010). “A First-Principles-Based Cell and Battery Simulation and Modeling Tool”. *Proceedings of the 44th Power Sources Conference*.
- Heun, Matthew Kuperus, J.L. van Niekerk, Mark Swilling, A.J. Meyer, A. Brent, and Tom P Fluri (May 17, 2010). “Learnable Lessons on Sustainability From the Provision of Electricity in South Africa”. *Proceedings of ASME 2010 4th International Conference on Energy Sustainability ES2010*, pp. 1–11.
- Heun, Matthew Kuperus, David P. Warners, and Henry E. DeVries (Apr. 15, 2009). “Campus Carbon Neutrality as an Interdisciplinary Pedagogical Tool”. *Proceedings of the Seventeenth Conference on the Domestic Use of Energy*, pp. 115–122.
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- Heun, Matthew Kuperus and Steven VanderLeest (May 22, 2008). “Why a Liberal and Multidisciplinary Education is Needed to Solve the Energy Crisis”. *Proceedings of the American Society for Engineering Education Annual Conference and Exposition*. AC 2008-2264, pp. 1–16.
- Heun, Matthew Kuperus (June 26, 2007). “Enhancing Engineering Education with Web-based Instrumentation Design Projects”. *Proceedings of the American Society for Engineering Education Annual Conference and Exposition*.
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- Pankine, Alexey A., Kim M. Aaron, Matthew Kuperus Heun, Kerry T. Nock, R. Stephen Schlaifer, Andrew P. Ingersoll, and Ralph D. Lorenz (Feb. 8, 2004). “Exploring Planets with Directed Aerial Robot Explorers”. *Space Technology and Applications International Forum–STAIF 2004*. Ed. by M.S. El-Genk, pp. 883–892.
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- Burger, Dale, Kim M. Aaron, Kerry T. Nock, Matthew Kuperus Heun, and Brenda Linfield (Jan. 8, 2001). “A Lightweight Modular Solar Array for Ultra-Long Duration Balloon (ULDB) Missions”. *Proceedings of the 39th AIAA Aerospace Sciences Meeting and Exhibit*. 2001-1148. DOI: 10.2514/6.2001-1148.
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Conference presentations

- Heun, Matthew Kuperus (Jan. 10, 2025). *Modeling Strategies*. Presentation to Montreaux Society Macroeconomics Modeling Workshop, London.
- Aramendia, Emmanuel, Matthew Kuperus Heun, Paul E. Brockway, and Zeke Marshall (June 19, 2024). *The Kaya Identity meets the energy conversion chain: Results and implications from a 155-country and world-level analysis covering 1971–2020*. Presentation at 15th Conference of the European Society for Ecological Economics, Pontevedra, Galicia, Spain.
- Hambye-Verbrugghen, Jérôme, Stefano Bianchini, Emmanuel Aramendia, Paul Brockway, Matthew Kuperus Heun, and Marshall Zeke (June 20, 2024). *Flipping the Switch: How Digital Intensity Shapes the Impact of Sectoral Growth on Energy*. Presentation at 15th Conference of the European Society for Ecological Economics, Pontevedra, Galicia, Spain.

- Heun, Matthew K., Gregor Semieniuk, and Paul E. Brockway (Mar. 27, 2024). *Energy, Expenditure, and Consumption Aspects of Energy Rebound: A Rigorous Analytical Framework*. Presentation to Economic Theory Workshop, UMass Amherst.
- Heun, Matthew Kuperus (July 10, 2024). *Exergy databases 5+2 speed talk*. Presentation at 2023 International Exergy Economics Workshop (IEEW2023), Chambery, France.
- Pinto, Ricardo, Sofia T. Henriques, Paul E. Brockway, Matthew Kuperus Heun, and Tânia Sousa (June 20, 2024). *World electricity efficiency: Comparing energy and exergy metrics from 1900 to 2017*. Presentation at 15th Conference of the European Society for Ecological Economics, Pontevedra, Galicia, Spain.
- Santos, João Alexandre, Paul E. Brockway, Tiago Domingos, and Matthew Kuperus Heun (June 21, 2024). *Global convergence in energy intensity of GDP: Analysis at primary, final, and useful stages of energy and exergy flows*. Presentation at 15th Conference of the European Society for Ecological Economics, Pontevedra, Galicia, Spain.
- Tostes, Bernardo, Sofia T. Henriques, Paul E. Brockway, Matthew Kuperus Heun, Tiago Domingos, and Tânia Sousa (June 20, 2024). *The evolution of world land transport from 1800 onwards: energy use, efficiency, and carbon emissions*. Presentation at 15th Conference of the European Society for Ecological Economics, Pontevedra, Galicia, Spain.
- Van Antwerp, Jeremy, Julie A. Field, and Matthew Kuperus Heun (June 25, 2024). *Sustainability designation, introductory course, and a new textbook in an engineering curriculum*. Presentation at 2023 American Society of Engineering Education Annual Conference and Exposition, Baltimore, Maryland.
- Heun, Matthew Kuperus (July 10, 2023). *Short run MR-PFU database*. Presentation at 2023 International Exergy Economics Workshop (IEEW2023), Chambery, France.
- Aramendia, Emmanuel, Paul E. Brockway, Matthew K. Heun, Peter G. Taylor, Jonathan Norman, and Zeke Marshall (June 16, 2022). *Estimation of useful stage Energy Return On Investment (EROI) of fossil fuel energy and required EROIs for renewable energy*. Presentation at European Society of Ecological Economics Annual Meeting 2022, Pisa, Italy.
- Brockway, Paul, Matthew Kuperus Heun, Zeke Marshall, and Emmanuel Aramendia (May 15, 2022). *World energy and exergy efficiency 1971–2019: Results and key insights*. Presentation at European Society of Ecological Economics Annual Meeting 2022, Pisa, Italy.
- Brockway, Paul E., Tania Sousa, Tiago Domingos, Tim Foxon, Carey W. King, Matthew Kuperus Heun, and Jonathan M. Cullen (June 27, 2022). *Exergy Economics: A tentative map of the field*. Plenary Presentation at International Exergy Economics Workshop 2022, Cambridge University.
- Heun, Matthew Kuperus (June 27, 2022). *Development of analytical tools for useful exergy analysis on the energy conversion chain*. Presentation at International Exergy Economics Workshop 2022, Cambridge University. Session 1.
- Heun, Matthew Kuperus, Gia Mien Le, Marta Baltruszczyk, Paul E. Brockway, and Lina Brand Correa (June 16, 2022). *Exploring the Interface Between Human Well-Being and the Energy Conversion Chain*. Presentation at European Society of Ecological Economics Annual Meeting 2022, Pisa, Italy.
- Heun, Matthew Kuperus, Zeke Marshall, and Paul E. Brockway (June 28, 2022). *Accounting for the Long Run*. Presentation at International Exergy Economics Workshop 2022, Cambridge University. Session 5a.
- Heun, Matthew Kuperus and Jeremy Van Antwerp (June 28, 2022). *A Framework for Sustainability Thinking: A student's introduction to global sustainability challenges*. Presentation at International Exergy Economics Workshop 2022, Cambridge University. Session 4.
- Tostes, Bernardo, Tânia Sousa, Paul Brockway, Sofia Henriques, and Matthew Heun (June 27, 2022). *The evolution of rail transport in the World from 1835 to 2020*. Presentation at International Exergy Economics Workshop 2022, Cambridge University. Session 2b.
- Brockway, Paul, Steve Sorrell, Gregor Semieniuk, Matthew Heun, and Victor Court (July 7, 2021). *Rebound effects may erode half the energy savings from improved energy efficiency: Implications for the Paris Agreement*. Presentation in Session 95: Materials, energy, waste & climate at ISEE-ESEE-Degrowth Online Joint Conference, 5–8 July 2021.
- Haney, Becky Roselius, Matthew Kuperus Heun, and Samantha Svoboda (June 2, 2021). “How might the coming climate crises change the way we teach economics? Using The Green Business Lab to help students connect the dots”. Presentation at the Tenth Annual American Economics Association Conference on Teaching and Research in Economic Education (CTREE).
- Heun, Matthew Kuperus (June 30, 2021). *Linking Micro and Macro Rebound Effects in a Partial Equilibrium Rebound Framework*. Presentation to Virtual International Exergy Economics Workshop 2021 (VIEEW2021).

- Brockway, Paul, Victor Court, Matthew Heun, Steve Sorrell, and Gregor Semieniuk (June 20, 2019). *Why faith in energy efficiency improvements to help meet the Paris Agreement could be misplaced: exploring evidence and implications of large, economy-wide rebound*. Presentation at European Society for Ecological Economics–ESEE2019, Turku, Finland.
- Heun, Matthew Kuperus (June 19, 2019). *A database for world primary, final, and useful energy and exergy information*. Presentation at European Society for Ecological Economics–ESEE2019, Turku, Finland.
- Heun, Matthew Kuperus and Paul E. Brockway (June 19, 2019). *Meeting 2030 primary energy and economic growth goals: Mission impossible? Application of physical supply-use table methods to energy conversion chain analysis for Ghana and the UK*. Presentation at European Society for Ecological Economics–ESEE2019, Turku, Finland.
- Rocco, Matteo Vincenzo, Zeus Guevara, and Matthew Kuperus Heun (June 19, 2019). *The energy effects of Brexit: Application of hybrid supply-use table methods to understand one of the largest economic shocks of our time*. Presentation at European Society for Ecological Economics–ESEE2019, Turku, Finland.
- Heun, Matthew Kuperus and Paul E. Brockway (June 21, 2017). “Energy access and pathways in the developing world: Case study—Ghana”. Presentation to European Society for Ecological Economics Conference, Corvinus University, Budapest, Hungary.
- Heun, Matthew Kuperus, Anne Owen, and Paul E. Brockway (June 28, 2017). “A physical SUT method to track energy flows from extraction to services”. Presentation to International Society for Industrial Ecology (ISIE) conference, University of Illinois at Chicago, Chicago, Illinois.
- Heun, Matthew Kuperus, João Santos, Paul Brockway, Marco Sakai, and Tiago Domingos (July 1, 2017). “Aggregate Production Functions: What measures can be taken to reduce the Solow residual?” Presentation at the 11th Biennial Conference of the European Society for Ecological Economics (ESEE2015), University of Leeds, Leeds, England.
- Heun, Matthew K., João Santos, Paul E. Brockway, Randall J. Pruim, Tiago Domingos, and Marco Sakai (July 15, 2016). “From theory to econometrics to policy: Cautionary tales for policymaking using aggregate production functions”. Presentation at the 2nd International Exergy Economics Workshop, University of Sussex, Sussex, England.
- Heun, Matthew Kuperus and Paul E. Brockway (July 14, 2016). “Useful Exergy in Ghana”. Presentation at the 2nd International Exergy Economics Workshop, University of Sussex, Sussex, England.
- Santos, João, Tiago Domingos, Paul Brockway, Marco Sakai, Matthew Heun, and Randall Pruim (Feb. 4, 2016). *Aggregate Production Functions and the Role of Energy in Economic Growth*. Presentation at Energy Economics Iberian Conference (EEIC), Lisbon, Portugal.
- Heun, Matthew Kuperus, Michael Carbajales-Dale, and Becky Roselius Haney (July 2, 2015). “Beyond GDP: National Accounting in the Age of Resource Depletion”. Presentation at *ESEE2015: The 11th Biennial Conference of the European Society for Ecological Economics*, University of Leeds, Leeds, England.
- Heun, Matthew Kuperus, Henry E. DeVries, Shane Muller, and Jeena Velzen (Oct. 12, 2011). “Development and Implementation of an Energy Recovery Fund”. Presentation at the Association for the Advancement of Sustainability in Higher Education (AASHE) Conference and Exhibition.
- Heffner, Gail, Matthew Kuperus Heun, and Claudia Beversluis (Feb. 23, 2010). “The Role of the Christian College in Fostering Creation Care”. Presentation at Critical Breakthroughs: International Forum on Christian Higher Education, Atlanta, Georgia.
- Halpert, Gerald, Kumar Bugga, Matthew Kuperus Heun, Abhijit Shevade, Ralph White, and Kerry T. Nock (Nov. 17, 2009). “A First Principles-based Li-Ion Battery Performance and Life Prediction Model Based on Single Particle Model Equations”. Presentation at NASA Aerospace Battery Workshop.
- Halpert, Gerald, Venkat R. Subramanian, Matthew Kuperus Heun, Ratnakumar Bugga, and Kerry T. Nock (Nov. 17, 2009). “A First Principles-based Li-Ion Battery Performance and Life Prediction Model Based on Reformulated Model Equations”. Presentation at NASA Aerospace Battery Workshop.
- Heun, Matthew Kuperus and Henry E. DeVries (June 11, 2009). “Designing and Establishing an Institutional Energy Efficiency Fund”. *Proceedings of the Sixth Conference on the Industrial and Commercial Use of Energy*, pp. 97–102.
- Halpert, Gerald, Matthew Kuperus Heun, Kerry T. Nock, Ratnakumar Bugga, and Ralph White (July 7, 2008). “A Unique Cell/Battery Performance Prediction Model Based on First Principles”. *Proceedings of the 43rd Power Sources Conference*, pp. 349–352.

Heun, Matthew Kuperus and David P. Warners (Nov. 11, 2008). “Campus Carbon Neutrality as a Pedagogical Tool”. Presentation at the Association for Sustainability in Higher Education (AASHE) Conference and Expo, Raleigh, North Carolina.

VanderWeide, John, Liaan Breen, Aaron Buys, and Matthew Kuperus Heun (Oct. 19, 2004). “Global System for Monitoring Earth Radiation Balance”. Presentation at 6th Annual NASA Institute for Advanced Concepts (NIAC) Meeting, Seattle, Washington.

Baker, Keith, Kerry T. Nock, Alexey A. Pankine, and Matthew Kuperus Heun (June 19, 2002). “Stratospheric Satellites for Disaster Monitoring”. *Proceedings of the Global Disaster Information Network (GDIN) Conference, Rome, Italy*.

Conference sessions chaired

Heun, Matthew Kuperus (June 19, 2024). *T8.3: Energy, resources, and energy/matter flow analyses*. Conference session chair at 15th Conference of the European Society for Ecological Economics, Pontevedra, Galicia, Spain.

Heun, Matthew Kuperus, Laura Felicio, and Bernardo Tostes (July 12, 2023). *Education Sharing Session*. Presentation at 2023 International Exergy Economics Workshop (IEEW2023), Chambéry, France.

Heun, Matthew Kuperus (June 27, 2022). *Dynamics 1*. Parallel session chaired at International Exergy Economics Workshop 2022, Cambridge University. Sessions 2a.

Heun, Matthew Kuperus (June 29, 2022). *Idea development for future projects and papers*. Sessions chaired at International Exergy Economics Workshop 2022, Cambridge University. Sessions 7 & 8.

Technical reports

Heun, Matthew Kuperus, A.J. Meyer, Thomas P. Fluri, and Warrick Pierce (Feb. 2010). *MeerKAT/SKA Energy Economics Modeling*. Technical report. University of Stellenbosch Centre for Renewable and Sustainable Energy Studies (CRSES).

Heun, Matthew Kuperus and J. L. van Niekerk (Jan. 20, 2010). *South African Renewable Energy Training, Research, and Education Centre (SARETREC)*. Business Plan 2.0. Centre for Renewable and Sustainable Energy Studies, Stellenbosch University.

Heun, Matthew Kuperus and William E. Dunn (July 1995). *Performance and Optimization of Microchannel Condensers*. ACRC Technical Report 81. Air Conditioning and Refrigeration Center, University of Illinois at Urbana-Champaign. URL: <https://www.ideals.illinois.edu/bitstream/handle/2142/11041/TR081.pdf>.

Heun, Matthew Kuperus (Aug. 11, 1989). *Automated Component Select*. Tech. rep. 8/11/89. Smiths Industries.

Conference poster sessions

Ver Beek, Noah, Matthew Heun, Paul Brockway, and Elvin Vindel (June 20, 2019). *Energy Use in Low GDP per Capita Nations: Societal Exergy Analysis of Honduras*. Poster Presented at European Society for Ecological Economics–ESEE2019, Turku, Finland.

Helmus, Tyler, Caleb Reese, and Matthew Kuperus Heun (Sept. 20, 2013). “Solving Systems of Equations with Multi-core Computers”. Poster accepted (but not presented due to schedule conflicts) for Consortium for Computing Sciences in Colleges Midwest Region Conference (CCSC:MW 2013), University of Findlay, Findlay, Ohio.

VanDyken, Ken, Joel Eigege, Daniel Mouw, Paul Sokomba, and Matthew Kuperus Heun (Mar. 23, 2004). “Global System for Monitoring Earth Radiation Balance”. Poster presented at 5th Annual NASA Institute for Advanced Concepts (NIAC) Fellows Meeting, Washington, D.C.

Seminar presentations

Heun, Matthew Kuperus (Jan. 30, 2025). “Linear algebra meets the energy conversion chain: How matrices organize data and enable analyses”. Seminar presentation to Calvin University Engineering Department and Mathematics Colloquium, Grand Rapids, Michigan.

Van Antwerp, Jeremy and Matthew Kuperus Heun (Oct. 18, 2022). “A Framework for Sustainability Thinking: A student’s introduction to global sustainability challenges”. Presentation at Book Launch event at Calvin University, Grand Rapids, Michigan.

Warners, David Paul and Matthew Kuperus Heun (Sept. 6, 2019). *Beyond Stewardship: New approaches to creation care*. Presentation at Christian Perspectives in Science Seminar, Calvin University.

Heun, Matthew Kuperus (Apr. 12, 2017). “Energy conversion chain (ECC) analysis: A proposed unifying physical supply-use table framework”. Presentation to Engineering Department Seminar Series, Calvin College, Grand Rapids, MI, USA.

- Heun, Matthew Kuperus (Apr. 22, 2015). “Energy and Macroeconomic Growth: 5 Propositions”. Seminar presentation to Calvin College Economics Department, Grand Rapids, Michigan.
- Heun, Matthew Kuperus, Michael Carbajales-Dale, and Becky Roselius Haney (Feb. 27, 2015). “Beyond GDP: National Accounting in the Age of Resource Depletion”. Presentation at Book Launch event at Calvin College, Grand Rapids, Michigan.
- Heun, Matthew Kuperus (May 23, 2014). “Saving Energy and Money with Green Revolving Funds”. Presentation at Centre for Renewable and Sustainable Energy Studies (CRSES) Forum, Sustainability Institute, Lynedoch, Western Cape, South Africa.
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