



## **Call for Research: Analysis of the Energetic Returns of Electric versus Internal Combustion Engine Vehicles (EV v. ICE) BioPhysical Economics Institute (BPEI)**

Grants of up to \$125,000 to be awarded for research projects on the energetic, emissions, and material life cycle of road vehicles.

### **Overview**

The BioPhysical Economics Institute (BPEI) supports research, training, networking, and dissemination efforts to inform a biophysical perspective on how materials and energy underpin the operation of the economy. This document is currently soliciting Letters of Inquiry (LoI) for a research project that will perform a comparison of the life cycle (supply chain through operation or end-of-life) of electric vehicles (EV) and internal combustion engine (ICE) light-duty or heavy-duty vehicles. The goal is to relate the work output and greenhouse gas emissions of vehicles to the energy and material inputs required during raw material extraction, manufacturing, operation, and end-of-life and recycling phases of a vehicle.

Upon review of the LoIs, BPEI might request further information for determination of the award. The grant amount is expected to be up to \$125,000 over a 12-month period. At its discretion, BPEI could choose to extend this study with additional funding.

### **Context**

BPEI is interested in analyzing and informing the energetic and material requirements for a low-carbon energy transition. Plans for decarbonization generally center on the mantra to “electrify every application possible and decarbonize the electric grid.” Electrification presents a large opportunity for changing the energy system, but there is also the need to understand the full costs and additional challenges from increased energy system electrification. While electrification is often seen as more energy efficient, the perspective of life cycle energy efficiency is often clouded by assumptions regarding the conversion of traditional fossil fuel primary energy stocks (e.g., coal, natural gas) as compared to renewable primary energy flows (e.g., sunlight, wind). Thus, end-use energy efficiency is not wholly sufficient to understand the use and productivity of different energy carriers and life cycles.

**In this request for LoIs, BPEI is seeking analyses that establish the comparative effectiveness of EVs and ICE vehicles from a full energy life cycle perspective.** The electrification of road vehicles (light-duty vehicles, LDVs) has been studied somewhat extensively from the perspectives of life cycle material flows (e.g., needs for lithium) and greenhouse gas emissions. However, there is less scholarship that has analyzed heavy-duty

vehicles (HDVs) or the energetic work output of vehicles (i.e., moving mass and cargo from point A to point B over some time) in relation to the life cycle energetic or work inputs. This is to say, the main purpose of vehicles is to transport cargo and people from one place to another. While the conversion of energy in the final energy carrier of the vehicle is critical, it is not the only important consideration because of the energy consumption embodied in vehicle manufacturing, maintenance, and end of life reuse, recycling, and disposal. BPEI is open to comparisons of LDVs or HDVs.

BPEI anticipates that this effort might extend the frameworks used for analysis of the so-called “energy return on energy invested” (EROI) of energy extraction and conversion technologies and industries. As an example, BPEI has previously conducted a study of energy saved on energy invested (ESOI) in the context new materials for power electronics (e.g., silicon carbide semiconductor devices vs silicon semiconductor devices). While most EROI studies end their analysis (draw system boundary) by assuming the output of the system under study is a final energy carrier (e.g., gasoline, electricity), in this Call for Research, BPEI is interested in ideas that can extend that boundary to **the work output (or useful work output) performed by vehicles during their use phase**. This extension is similar to considering Scope 3 greenhouse gas emissions that include use-stage of products.

The intention of this Call is to be relevant to scholars, disciplines, and approaches that use quantitative frameworks, such as mathematics used in engineering analysis and life cycle assessment (LCA). The goal is to advance energy system analysis and scholarship that produces novel research, (possibly) student training, strengthened research networks, and dissemination of findings to inform decision-making for businesses and/or government policy.

The core proposal team will perform analyses and document findings, whereas a team from BPEI, which might include Advisory Board members of BPEI, will act as advisors to give feedback on methods during the research project.

### **Expected Project Structure**

- Projects that involve student researchers are expected to contain a student training component (graduate students, postdoctoral researchers, or undergraduates) to enhance attention to questions of energy system electrification.
- Projects are expected to undertake original empirical data collection, analysis, and/or combine existing datasets in novel, innovative ways using SimaPro LCA software, or another similar tool, to facilitate data to inform the research.
- Projects are expected to link research to practice by engaging stakeholders in either the conduct of research or in dissemination efforts used to inform decision-making. This includes potential collaboration with government, industry, non-governmental organizations, or other stakeholder organizations via conferences, meetings, webinars, or

other means. BPEI will facilitate some communication by enabling the team to discuss results during a BPEI-arranged webinar at the end of the project.

- Cost sharing is of interest to BPEI. If the project team has the potential ability to secure additional financial support, or in-kind contributions, from other funding sources—including foundations, universities, private sector, or government funders—then this should be mentioned in the LoI by describing how the research team will leverage these funds.
- Projects involving advocacy or lobbying activities are out of scope and not eligible for consideration. Additionally, projects with a public health or biomedical component are out of scope and not eligible for consideration.
- The project team will conduct quarterly update meetings with the BPEI grants team, including one meeting in the first few weeks of the project.

### **Expected Team Structure and Eligibility**

- Lead principal investigators, co-principal investigators, and other research personnel can be from for-profit companies or non-profit organizations such as universities. No member of the research team needs to hold any particular position such as a tenured or tenure-track faculty position. Each member of the research team must be eligible to work in a country with current trade relations with the United States, US for profits and entities registered as US non-profits can apply. Final budgets will need to be negotiated before finalizing the award.
- Project researchers can have formal training within and feature collaboration among scholars deploying a range of research methodologies and drawing from multiple social science, engineering, or natural science disciplines. Relevant disciplines and fields could include but are not limited to: engineering, physics, political science, public policy, economics, anthropology, sociology, geography, and energy systems analysis, among others.
- Researchers may be a part of **only one** submission to this Call for Research.

### **Submission Deadline and Instructions**

**Submissions are due on Wednesday, May 31, 2023, by 5:00pm Eastern Time.** Submission materials must be integrated in a single PDF document and emailed to [proposals@bpeinstitute.org](mailto:proposals@bpeinstitute.org), with the following subject heading and document title: “EV\_vs\_ICE LOI - Lead PI Last Name – Lead Institution Name”.

## Submission Components

Complete submission packets should include the following 6 components in the following order:

**(1) A 1-page Biophysical Economics Institute Proposal Cover Sheet**, summarizing key project details. Projects should have a proposed start date of **September 1, 2023**. This Cover Sheet document is available at: [www.bpeinstitute.org/grants](http://www.bpeinstitute.org/grants)

**(2) A Letter of Inquiry up to 4 pages in length (excluding budget table and other supplemental material), in 11-point font. The LoI should discuss how the research will (at least) meet the minimum required scope of the research:**

- **Minimum Goals & Scope**
  - Life cycle energy (or exergy) consumption, including assumed driving cycles and lifetime distance traveled
  - Life cycle use of important non-energy resources (e.g., metals and other feedstocks)
  - Life cycle greenhouse gas emissions
  - End-of-life considerations (recycling, waste)
- **Additional (possible) Goals and Scope**
  - Other air emissions

Submissions should address the following questions, with each question serving as a section heading:

- What are the current knowledge gaps that this research will need to address the scope of research, and what types of road vehicles will be studied?
- What are the proposed research methods, mathematical or organizational framework, and anticipated model inputs and data sources?
- What are the team's qualifications, and what are the roles of each participant (including any students)?
- What will be the outputs and deliverables from the research project (e.g., report, computer programs, journal paper submission) and how will they be disseminated among various stakeholders?
- What other sources of support can the project leverage?
- Do you declare any conflicts of interest? (If “no”, then include the following statement “The research team declares no conflicts of interest and acknowledges that if such conflicts are discovered during the course of the research, BPEI can cancel the research project and request all project funds be returned.”)

**(3) A Budget Table (Excel template) and a Budget Justification (textual narrative)** explaining each expense for the proposed project. Total funding requests are allowed up to \$125,000 over a 12-month period, with sub-awards to collaborating institutions where needed. A sample Budget Table for use in the submission is available at: [www.bpeinstitute.org/grants](http://www.bpeinstitute.org/grants). Allowable expenses include:

- For faculty: up to one-month summer salary per investigator per year, plus benefits, capped at \$35,000 per investigator per year, based on project time commitment.
- For non-faculty researchers, salary can include summer salary per investigator per year, plus benefits, capped at \$35,000 per investigator per year, based on project time commitment.
- For graduate students, postdoctoral researchers, or undergraduate students: salary/stipend, plus benefits, based on project time commitment.
- Tuition reimbursement: Requests for graduate student tuition reimbursement are allowed up to a maximum of \$12,000 per student per academic year, with written justification. For project-related administrative and research staff: salary, plus benefits.
- Research implementation expenses: data acquisition, software, conducting experiments, computation, hardware, advisory committee honoraria, and other research expenses.

*NOTE: At no extra cost to the research team (e.g., do not include in budget) BPEI can provide access to the SimaPro life cycle assessment software for general life cycle inventory and material use data.*

- Dissemination and workshop expenses: travel, meals, lodging, conference fees, room rentals, speaker stipends, audio-visual equipment, and other dissemination expenses.
- Indirect overhead expenses, capped at 20% of direct costs (overhead expenses are not allowed on tuition reimbursement).

**(4) References/Bibliography List** of up to 2 pages

**(5) Brief CVs** of key project leads and personnel (no more than 2 pages per person)

**(6) If applicable, Letters of Support** from research partners, community stakeholders, data providers, or other collaborators.

### **Submission Review Process**

BPEI will be able to respond to basic clarifying questions for additional information related to this Call for Letters of Inquiry. A review committee comprised of scholars and practitioners with expertise in energy system analysis and life cycle assessment will review submitted Letters of Inquiry. A small number of selected submissions might then be invited to submit additional information for consideration, in response to reviewer questions. These responses will be further reviewed by subject matter experts.

Depending on the details within submissions received, it is expected that 1 (possibly 2) grant will be awarded with an award decision expected by July 31, 2023.

**About the Biophysical Economics Institute**

The BioPhysical Economics Institute (BPEI) is a non-partisan, non-profit, multidisciplinary organization of scientists, economists, investment experts, corporate & project finance analysts and policy professionals, who are working together to bring the natural sciences into economic analysis and decision making. Specifically, BPEI aims to incorporate the analysis of energy efficiency into assessments of various strategies to reduce our reliance on fossil fuels, while supporting our natural habitats and human flourishing.

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