Opportunity Title: Consortium of Hybrid Resilient Energy Systems Professional Internship Program (PIP) 2022
Opportunity Reference Code: NETL-CHRES-2022-PIP

Organization National Energy Technology Laboratory (NETL)

Reference Code NETL-CHRES-2022-PIP

How to Apply A complete application consists of:

- Profile information
- Educational details
- Relevant experience
- Awards and honors
- Goals, experience, and relevant skills
- Transcripts – Click here for detailed information about acceptable transcripts
- A current resume/CV, including academic history, employment history, relevant experiences, and publication list
- Two educational or professional recommendations

All documents must be in English or include an official English translation. All information and documents must be submitted via Zintellect to be considered for an appointment at the National Energy Technology Laboratory (NETL).

If you have any questions, contact NETLinfo@orau.org.

The Consortium of Hybrid Resilient Energy Systems (CHRES)

The Consortium of Hybrid Resilient Energy Systems (CHRES) program provides summer internship opportunities to undergraduate students, graduate students, recent graduates, and faculty affiliated with the four Consortium member universities: Universidad Ana G. Méndez, Universidad de Puerto Rico - Mayagüez, University of New Mexico, and University of Texas at El Paso. The CHRES program directly supports the U.S. Department of Energy's (DOE's) goal of building a sustainable professional and academic pipeline of the next generation of engineers and scientists, ready to take on the challenges of current and future energy systems.

Program Objectives

The program's objectives are to:

- Provide research and educational experiences to minority students by continuing and improving the consortium programs.
- Increase interaction between partners and between partners and national laboratories.
- Encourage minority students to excel in science, technology, engineering and math by providing them with practical experience and training through project capacity building and learning experience.
- Enlarge scientific, technical knowledge and resource base in the topics of resilient energy (engineering).

The emphasis on a mentored research experience allows CHRES participants to become integral members of NETL's **Hy**brid **Per**formance (HYPER) Facility. Participants gain exposure to current national issues in science and technology, have opportunities to share and exchange

Opportunity Title: Consortium of Hybrid Resilient Energy Systems Professional Internship Program (PIP) 2022
Opportunity Reference Code: NETL-CHRES-2022-PIP

innovative ideas and techniques, and make significant contributions to hybrid energy systems and grid resilience projects. To learn more about the HYPER Facility, visit https://www.youtube.com/watch?v=VP1QE5juPOo.

Program Details

- Ten week research experience
- Full-time participation (40 hours/week)
- Appointments will start on **Monday, June 6, 2022** and end on **Friday, August 12, 2022**
- Participants receive a biweekly **stipend** based on their educational level. Stipend payments are taxable as an educational benefit. **Stipends** start at $436/week - $600/week for undergraduate students, or $670/week to $1,020/week for graduate students.
- On-site participants at NETL's facility may be eligible for **inbound/outbound travel support** of up to $1,000 and a **housing allowance** of $100/week
- Off-site participants may receive up to $1,000 for **technology support** near the beginning of their appointment
- All CHRES participants are required to present their research project activities and outcomes at the end of the program. This will include a 10-15 minute oral presentation at the CHRES Technical Forum and a 1-2 page extended abstract (research summary).

Application Deadline 1/31/2022 3:00:00 PM Eastern Time Zone

Description Students and recent graduates are sought to engage in collaborative research with scientists at NETL's Research and Innovation Center (R&IC). Individual projects will be modified to accommodate the interest of students or professors participating in the project. In addition to the projects listed below, other projects could be developed if there is sufficient interest.

NETL's **Hy**brid **Per**formance (HYPER) facility is a one-of-a-kind facility built to evaluate dynamic operations and to develop control strategies for solid oxide fuel cell / gas turbine (SOFC-GT) hybrids, with expanded reconfigurability and capability. To exploit the advantage of both numerical models and physical systems, as well as gapping the inaccessible technologies, a cyber-physical system (CPS) approach was implemented at the HYPER facility. A CPS fuel cell system was built and integrated with turbomachinery and other supporting components in real time, forming a pilot-scale SOFC-GT integrated system.

NETL's HYPER team is seeking researchers for projects in the following areas:

1. **Fuel Processing and Fuel Flexibility**
   One particular research interest of the HYPER project is to explore the capability of this hybrid technology under a fuel flexible environment. A one-dimension reformer was built and implemented with the SOFC model in the dSPACE platform. This project will engage in a fuel flexibility modeling study to determine the impact of an array of

secondary fuels on SOFC-GT cycle efficiency, and to identify key performance and cost drivers.

2. **Fuel Cell Degradation**
   Fuel cell stack degradation has a big impact on facility costs and operations. This project will use additional experimental data to optimize the HYPER project's existing degradation model, with the expectation to test the control strategy (all the controllers simultaneously) on the HYPER facility. The project will also include characterizing of the system in a broad range of operating conditions while the cell is degrading.

3. **System Analysis**
   A novel cycle, composed of a solid oxide electrolyzer cell (SOEC), a solid oxide fuel cell (SOFC), an internal combustion engine (ICE), thermal management, and carbon capture technologies is proposed. This cycle aims to investigate the efficient and cost-effective production of hydrogen and electricity. System studies will be performed for cycle optimization to improve lifespan, efficiency, costs, and operability.

4. **Mitigating Compressor Surge and Stall**
   Compressor surge and stall is one of the main operational challenges in SOFC-GT hybrid systems. The problem arises because of the added large volume between compressor and gas turbine and resultant changes to system fluid dynamics. This project will focus on examining several methods for detecting and mitigating compressor surge and stall during transient operation. The compressor stall and surge and its recovery will be characterized at different transient states in the SOFC-GT hybrid system. Acoustic measurements will be used to detect or confirm the onset of compressor stall and surge. An automated compressor surge recovery will be demonstrated using a cold air bypass strategy at nominal speed and for emergency shutdown.

5. **Integration of Energy Storage into Hybrid Power Cycles**
   The aim of this project is to evaluate the potential for energy storage in hybrid power cycles to enable more effective load following. This will build upon the analysis conducted previously that included both renewables and SOFC-GT hybrids. Energy storage concepts will be simulated and virtually integrated into hybrid cycles. They will be tested for their ability to provide flexibility and resiliency in power systems which have a high proportion of variable renewable power sources, such as wind and solar.

6. **Performance Degradation and On-Line System Identification**
   It is clear from previous work that an adaptive control approach will be required for highly coupled advanced power systems as components degrade to maintain performance targets. As part of the HYPER project, single-input single-output controllers have been designed to regulate variables that directly affect component degradation in a hybrid system.

The project goal is to improve performance and extend power system component lifespan using advanced controls and artificial intelligence. NETL researchers are developing an innovative continuous monitoring system to characterize drift from optimal performance by conducting on-line system identification. During this project, degradation of specific components will be characterized using the on-line system identification at nominal and off-design conditions.

7. **Developing Cyber-Physical Reformer**
   NETL researchers have pioneered the cyber physical approach to enable rapid evaluation of a variety of operational configurations while maintaining the accuracy of process dynamics. A cyber-physical reformer incorporates real-time models, experimental hardware, and dynamic data transfer and control. Tests will be planned, conducted, and analyzed to verify dynamic models and evaluate the process limitations of extracting the heat from either auto-thermal reforming, heat exchange in turbine exhaust, or from the SOFC itself.

8. **Automated Startup and Shutdown of SOFC-GT Hybrid System**
   One inherent complexity of the SOFC-GT hybrid system comes from wide discrepancies in the individual component response times, affecting the startup and shutdown of the hybrid system critical dynamic operations. For turbomachinery, this will involve avoiding compressor surge and stall. For the fuel cell system, it will require the thermal management and electrochemical light-off. This project will analyze previous system identification data and develop and demonstrate an automated dynamic control within the constraints of the supervisory control.

9. **Load Following and Supervisory Control**
   The penetration of renewables requires other power plants to have a rapid load following. This project will investigate the SOFC-GT's load following ability by operating the HYPER facility in response to Idaho National Lab's grid simulator demand. A supervisory control scheme for load will be developed. The objective is to divide power generation between the fuel cell and the turbine during power demand changes, i.e. responding faster with the gas turbine and then adjusting the fuel cell load over time, while avoiding excessive temperature oscillation in the fuel cell. Temperature variation represents a constraint in the control problem.

10. **Machine Learning and Digital Twin**
    Cyber-physical modeling provides a new modeling paradigm that has the potential to accelerate the design, deployment, and scale-up of advanced energy systems. Cyber-physical models can grow and change during the design and deployment process, and ultimately support development of the digital twin and the physical system of the embodied power plant. This project will use HYPER facility and operational data for machine learning and digital twin research.

zintellect
climb higher

Opportunity Title: Consortium of Hybrid Resilient Energy Systems Professional Internship Program (PIP) 2022
Opportunity Reference Code: NETL-CHRES-2022-PIP

Qualifications The ideal candidate would have a strong background in some, but not all, of these elements: MATLAB-Simulink programming, thermodynamics, middleware interface, and dynamic controls.

Eligibility Requirements

- **Citizenship:** U.S. Citizen Only
- **Degree:** Associate's Degree, Bachelor's Degree, Master's Degree, or Doctoral Degree.
- **Overall GPA:** 2.50
- **Discipline(s):**
  - **Chemistry and Materials Sciences** (12 👁)
  - **Communications and Graphics Design** (2 👁)
  - **Computer, Information, and Data Sciences** (17 👁)
  - **Earth and Geosciences** (21 👁)
  - **Engineering** (27 👁)
  - **Environmental and Marine Sciences** (14 👁)
  - **Life Health and Medical Sciences** (46 👁)
  - **Mathematics and Statistics** (10 👁)
  - **Physics** (16 👁)
  - **Science & Engineering-related** (1 👁)
  - **Social and Behavioral Sciences** (28 👁)
- **Age:** Must be 18 years of age

Affirmation I certify that:

1. To the best of my knowledge all information contained in this application is accurate
2. I meet **one of** the following academic status criteria:
   - I am a current undergraduate student
   - I have completed a Bachelor's degree within the last two years
   - I am a current graduate student and have not received a Master's degree within three years.
     [If you have received a Master's degree within the last three years, please apply to the Postgraduate opportunity.]
3. I am a current student at one of the following universities:
   - Universidad Ana G. Méndez
   - Universidad de Puerto Rico - Mayagüez
   - University of New Mexico
   - University of Texas at El Paso
4. I understand that any falsification will render me ineligible for participation and, if found after participation has begun, may require me to reimburse any funds received