Funded Graduate Research Assistant (GRA) Position

In thermal-electric modeling, optimization, and control of hybrid energy systems
Prof. Mads R. Almassalkhi's CORE Systems Lab @ University of Vermont, Burlington, VT

With the support of the Department of Energy's Solar Energy Technologies Office (SETO), the CORE Systems Lab (Control & Optimization of Renewable Energy Systems Lab) is recruiting Ph.D. applications from creative, motivated, and bright students in *thermal-electric battery modeling, optimization, and control*. The GRA position is a fully funded 12-month position for up to 4 years and includes future internship opportunities with collaborators at national laboratories and/or energy industry. The position's expected start date is Spring 2023 or Fall 2023. Underrepresented groups are strongly encouraged to apply.

Research project summary:

Hybrid energy systems (HES), which integrate different energy infrastructures (e.g., heat, energy storage, electric generation, inverters), can achieve greater energy and economic efficiencies than either element on its own. In addition, advanced modeling, control, and optimization tools can further enhance capability and performance of a HES, which unlocks the potential of the HES to deliver advanced grid service. However, the interaction and dynamics of the different components in an HES makes it inherently complex to operate. In cold weather climates, low temperatures and precipitation add several challenges to optimization and control of HES as these **thermal-electric effects** impact each component differently. The goal of this project is to understand, quantify, and improve HES long-term performance in cold environments, such as in Burlington, VT.

Tackling challenges associated with both fast (operational) and slow (planning and degradation) timescales in this project **will enable a holistic techno-economic analysis of HESs in cold weather climates**. Thus, the **project's outcomes** will be (1) advanced modeling, control, and optimization tools for HESs across a range of temperatures and timescales suitable for operation and planning; (2) lab-based analysis and validation of these new tools in a new accelerated testing laboratory (ATL) at UVM enabled by kVA-scale hardware-in-the-loop (HIL) platform and; (3) field validation of the tools at a new Hybrid Solar Test Center (HSTC) in Burlington, Vermont. The HSTC will be a unique, advanced demonstration facility for cataloging and studying techno-economic advantages and challenges of HESs in northern climates, including the potential for workforce and technology development. Upon project completion, we will deliver a techno-economic analysis on the expected benefits from and challenges with HES in northern climates.

Helpful background for a Ph.D. applicant: a competitive application should clearly demonstrate effective communication skills (written and visual), ability to work independently, and *some experience with at least three (3)* of the following:

- Mathematical optimization (e.g., convex, non-linear, or mixed-integer optimization)
- Control theory (e.g., optimal control, predictive control, or state-space methods)
- Machine learning/data-driven methods (e.g., using Matlab or PyTorch or TensorFlow)

- Power and energy systems (e.g., voltage & frequency regulation, markets, transient, power quality)
- Coding large or realistic grid simulations (e.g., MatPower, GridLab-D, Julia, C++, Python, EMTP, or Matlab)
- Lab-based characterization or model validation (e.g., real-time hardware-in-the-loop or HIL simulation)
- Industry experience implementing any of the above in the field (e.g., M&V, standards testing, design)

Preference will be given to applicants from underrepresented groups who can demonstrate ability to work creatively and those with an MS degree.

For international students, your **IELTS/TOEFL/DuoLingo score must exceed 7.0/100/120 to qualify for funding.**

To apply:

- Please follow instruction here: https://www.uvm.edu/graduate/application_instructions
- Please feel free to follow up with me via email and share your research interests and communicate why you believe they align with the position here an include CV and unofficial transcripts, too.

Contact info
Mads R. Almassalkhi, malmassa@uvm.edu
L. Richard Fisher Associate Professor in Electrical Engineering @ University of Vermont
Chief Scientist @ Pacific Northwest National Laboratory (PNNL; Joint appointment)
Google Scholar | LinkedIn | Website
Twitter: @theEnergyMads