Neural Network-Based Modeling of Reversible Fuel Cells for Hydrogen Production

CHEN4011 Final Project - Semester 2, 2023

2023-08-31

Introduction

Globally, the primary contributors to greenhouse gas emissions are sectors like transportation, electricity production, and industrial activities. Green hydrogen, generated through water electrolysis using renewable energy, is increasingly seen as a viable option to reduce carbon emissions in high-energy-demand sectors such as aviation and industrial manufacturing. While the majority of hydrogen is currently derived from natural gas reforming, a process that emits greenhouse gases, the focus is shifting towards the scalable and cost-effective production of green hydrogen. One of the critical challenges is balancing the inconsistent availability of renewable energy with the ongoing electrical needs of the grid.

Problem description

In this project, you will develop a neural network-based model to simulate a reversible fuel cell that can function both as an electricity generator and as an electrolyzer. Such a model could be integrated into a simulated renewable energy microgrid to explore different operational profiles and configurations.

The ultimate aims are a) to evaluate energy needs and sizing requirements for achieving specific hydrogen production goals. b) propose control strategies for effective control of the fuel cell.

The insights derived from the model will be used to make data-driven recommendations about promising configurations and supportive technologies.

Suggested steps

1. Review existing renewable energy and fuel cell models. Prepare a brief literature review summarizing your findings.

2. Use the simscape model available at https://au.mathworks.com/help/simscape/ug/pem-electrolysis-system.html as a foundational resource to generate required data for the neural network model.
3. Develop a neural network-based model for the reversible fuel cell. This model should be capable of simulating both electrolysis and electricity generation processes.
4. Identify control, manipulated, and disturbance variables. Propose and evaluate appropriate control strategies.

Report

Prepare a report consisting of the following:

1. Predictive modeling of PEM electrolyzer (20 marks): Present a comprehensive note (5 – 6 pages) on the state of the art of use of data driven modeling for design, control, and optimization of PEM electrolyzer for hydrogen production.
2. ANN model for a PEM electrolyzer (NF/RO) plant (40 marks):
3. Control strategy for PEM electrolyzer (20 marks)
4. Critical review (10 marks) Present a critical review of your modeling and control activity. Some key guiding questions (not limited to) are: Why should we believe your simulations? What worked, What did not work? How to improve the simulations?

Marking

The report will be marked as follows:

Description	Marks
Part 1: Short note: Predictive modeling of PEM electrolyzer	20
Part 2: ANN Model for PEM electrolyzer	40
Part 3: Control of PEM electrolyzer	20
Critical Review	10
Report Presentation	10
Total	100

Submission

1. The project is conducted in a group of five.
2. You are free to choose your group.

3. Please notify the instructors of your groups as soon as you form them.
4. If you cannot find a group, please get in touch with your instructor at the earliest.
5. You will need to submit all the files created electronically on blackboard.
6. There should be one submission per group.
7. Please follow the instructions given below carefully for preparing the files for submission. Failure to follow these instructions may result in us not being able to assess the files.

   You will be uploading two files.

   1. Report (pdf file containing the report). You need to name the file as STUDENTID_CHEN4011_project_report.pdf (Replace STUDENTID with your Student ID). You need to make only one submission per group.
   2. Create a zip file named STUDENTID_CHEN4011_project_Supporting_files.zip. The zip file should contain a) All supporting files for modeling, simulation, and control activities (matlab, simulink) b) the PDF report file. You may upload the supporting file to a cloud storage of your preference and share a link.