



# **SOLAR-HYDROGEN POWERED PROTON EXCHANGE MEMBRANE FUEL CELL (PEMFC) MODELING AND SIMULATION**

A dissertation submitted to the  
Department of Electrical Engineering, University of Moratuwa  
In partial fulfillment of the requirements for the  
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by  
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## Abstract

The main scope of this study provides a research insight on direct solar Hydrogen-proton exchange membrane fuel cell concept and the description of fuel cell operating principles is followed by a modeling and simulation of the current fuel cell technology together with issues concerning Hydrogen fuel. Appropriate applications for current and perceived potential advances of fuel cell technology are discussed.

Fuel cell modeling is helpful for fuel cell developers because it can lead to fuel cell design improvements, as well as, better, and more efficient fuel cells. The model must be robust and accurate and be able to provide solutions to fuel cell problems quickly. A good model should predict fuel cell performance under a wide range of fuel cell operating conditions. Even a modest fuel cell model will have large predictive power. The necessary improvements for fuel cell performance and operation demand better design, materials, and optimization. These issues can only be addressed if realistic mathematical process models are available.

Fuel cells are one of the cleanest and most efficient technologies for generating electricity. Since there is no combustion, there are none of the pollutants commonly produced by boilers and furnaces. For systems designed to consume hydrogen directly, the only products are electricity, water and heat. Fuel cells are an important technology for a potentially wide variety of applications including on-site electric power for households and commercial buildings; supplemental or auxiliary power to support car, truck and aircraft systems; power for personal, mass and commercial transportation; and the modular addition by utilities of new power generation closely tailored to meet growth in power consumption. These applications will be in a large number of industries worldwide.

The theoretical development of the proton exchange membrane fuel cell (PEMFC) is discussed with the areas under electro chemistry, thermal distribution, and pressure. The particular simulations and modeling are discussed by using modeling software.

## DECLARATION

The work submitted in this dissertation is the result of my own investigation, except where otherwise stated.

It has not already been accepted for any degree, and is also not being concurrently submitted for any other degree

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## List of Principal Abbreviations

DMFC	Direct methanol fuel cell
EMF	Electromotive force
HHV	Higher heating value
LHV	Lower heating value
MCFC	Molten carbonate (electrolyte) fuel cell
MEA	Membrane electrode assembly
MOSFET	Metal oxide semiconductor field-effect transistor
NASA	National Aeronautics and Space Administration
PAFC	Phosphoric acid (electrolyte) fuel cell
PEM	Proton exchange membrane or polymer electrolyte membrane – different names for the same thing which fortunately have the same abbreviation
PEMFC	Proton exchange membrane fuel cell or polymer electrolyte membrane fuel cell
PTFE	Polytetrafluoroethylene
SOFC	Solid oxide fuel cell
CB&H	Carbon Black & Hydrogen Process
GE	General Electric
AFC	Alkaline Fuel Cells
GDL	Gas Diffusion Layer
PV	Photovoltaic