# DEVELOPMENT OF MULTI-AGENT SYSTEM BASED ENERGY MANAGEMENT SYSTEM FOR MICRO GRIDS

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188118G

Degree of Master of Science by Research

Department of Electrical Engineering

University of Moratuwa

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## DECLARATION

I declare that this is my own work and this thesis does not incorporate without acknowledgement any material previously submitted for a Degree or Diploma in any other University or institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

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The above candidate has carried out research for the Masters~~/MPhil/PhD thesis/~~ Dissertation under my supervision.

Name of the supervisor: Prof. W.D.A.S Wijayapala

Signature of the supervisor: 5/6/2020

Name of the supervisor: Prof. K.T.M.U Hemapala

Signature of the supervisor: 5/6/2020

# ABSTRACT

In this thesis, our objective is to introduce multi agent concept for the energy management of micro grids. This objective is very significant as micro grids are emerging as a method to integrate the operation of distributed energy sources (DES) in modern power systems. They introduced advanced communication technologies, optimizing techniques, sensing and monitoring features for the power distribution network. However, optimal energy management is still a challenge for microgrids when controlling renewable DES's with intermittent generating patterns. In this research, a Multi Agent System (MAS) based architecture is used for the operation of energy management system (EMS) of a microgrid. The objective of this research is to implement an agent based control architecture for DES's, loads and energy storage systems (ESS) of a microgrid to achieve optimal energy management. This document discusses the modeling, simulation and hardware implementation of agent based energy management system. Initially, JADE (Java Agent Development Environment) is used to implement the agent based control architecture. A microgrid is modeled in Matlab/Simulink and interlinked with agents developed in JADE through a middle layer. The decision making authority is shifted to ground hierarchy, enabling local agents to take control over DES's to optimize the renewable power consumption. The outcome of this research shows that MAS based control architecture can be used to optimize the energy management in a microgrid. This thesis presents a complete literature review about the background of this research and similar projects, and the results obtained through the research in both simulation and hardware implementation in developing a multi agent based energy management system for a micro grid.

*Keywords— Agents, Multi agent systems, Energy management, microgrid, JADE*

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H.V.V. Priyadarshana.

# TABLE OF CONTENT

## LIST OF FIGURES

# LIST OF TABLES

## LIST OF ABBREVIATIONS

| | |
|---|---|
| ABEMS | Agent Based Energy Management System |
| ACL | Agent Communication Language |
| ABM | Agent Based Modeling |
| ADK | Agent Development Toolkit |
| AMS | Agent Management System |
| CLP | Critical Load Power |
| CEMS | Centralized Energy Management Systems |
| DEMS | Distributed Energy Management Systems |
| DER | Distributed Energy Resource |
| DSM | Demand-side management |
| DF | Decision Function |
| EMR | Electro Mechanical Relay |
| EMS | Energy Management Systems |
| GHG | Green House Gas |
| IoT | Internet of Things |
| IPCC | Intergovernmental Panel on Climate Change |
| JADE | Java Agent Development Environment |
| LCD | Liquid Crystal Display |
| MEMS | Multi-agent Energy Management Systems |
| MAS | Multi Agent System |
| NCLP | Non-Critical Load Power |
| NCRE | Non-Conventional Renewable Energy |
| PCC | Point of Common Coupling |
| RER | Renewable Energy Resource |
| SCADA | Supervisory Control and Data Acquisition |
| SSR | Solid State Relay |
| TSD | Two Stage Dispatch |
| TLP | Total Load Power |
| TFT | Thin Filmed Transistor |
| TRP | Total Renewable Power |
| WTP | Wind Turbine Power |