UMBC

Artificial Intelligent Controller-Based Power Quality Improvement

for

Microgrid Integration of Photovoltaic System

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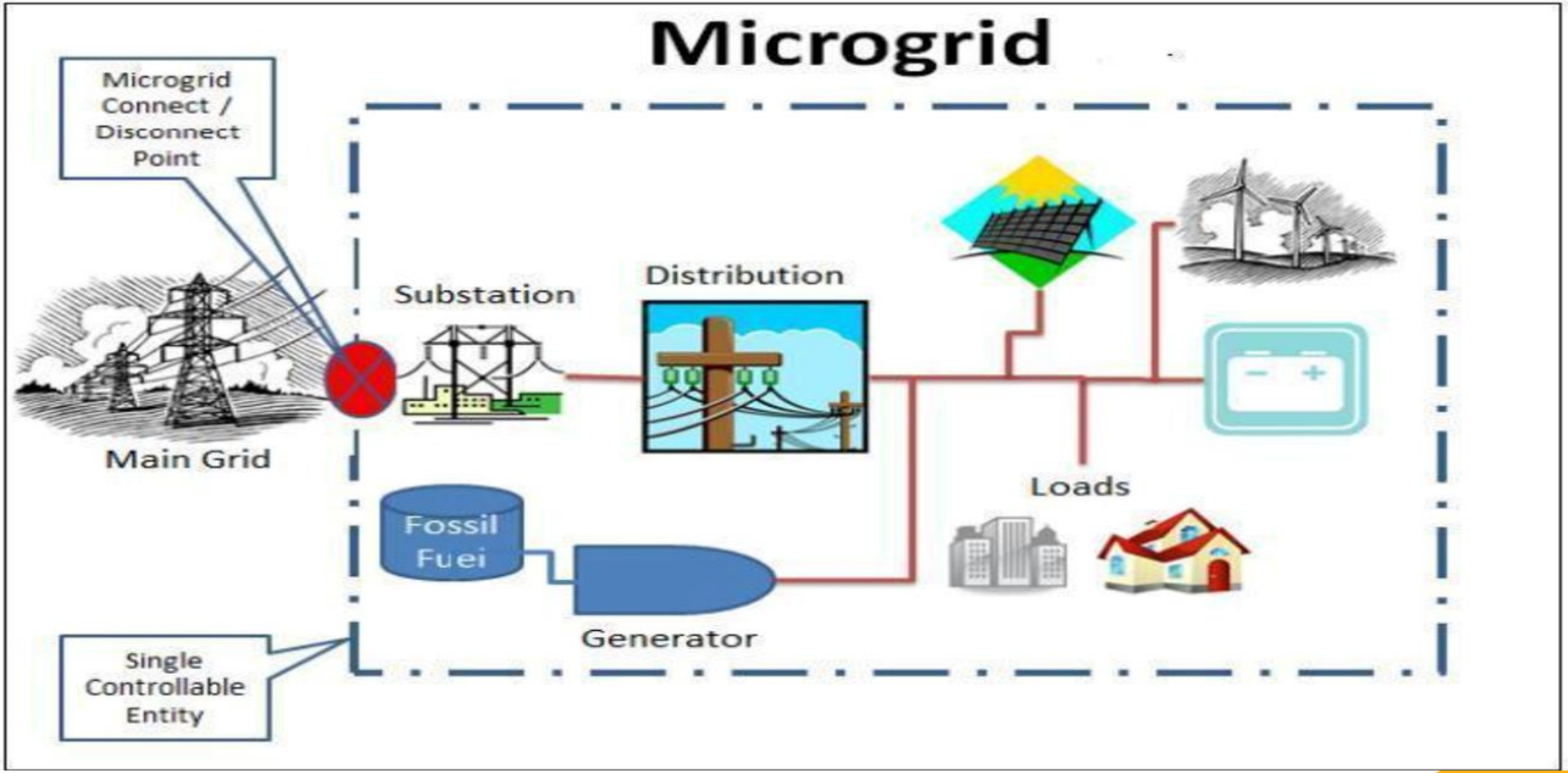
Objectives

- To implement AI controller-based maximum power point tracking (MPPT) algorithm on Microgrids
- To present a new cascade multilevel inverter (MLI) to reduce the total harmonic distortion (THD)
- The microgrid integration of inverter is controlled by using AI-based voltage source controller

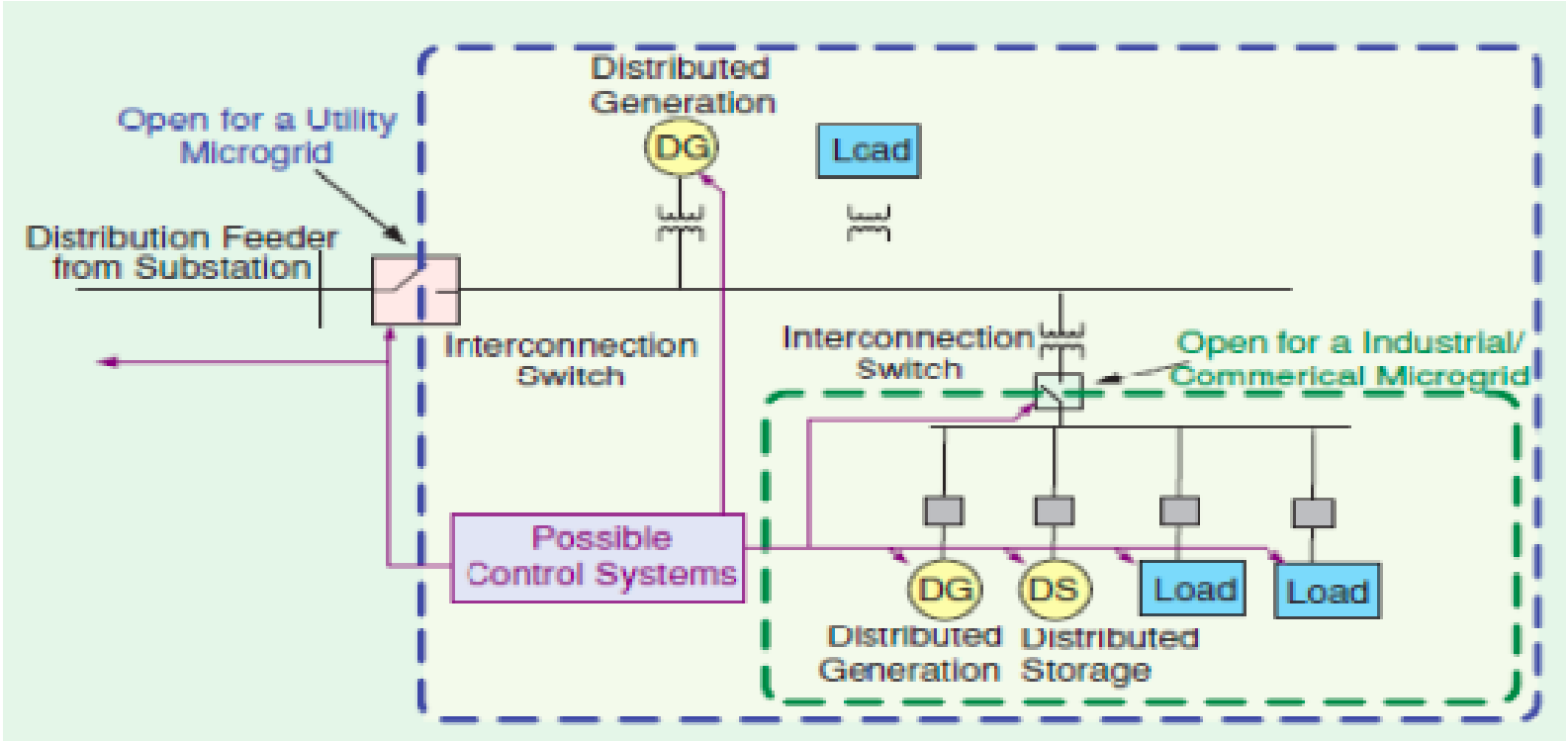
BACKGROUND


Microgrid
Microgrid Connect / Disconnect Point
Substation
Distribution
Main Grid
Loads
Fossil Fuei
Generator
Single Controllable Entity

BACKGROUND

- A microgrid is a small electricity generation and distribution system containing distributed generation, energy storage systems, loads and monitoring and protection devices.
- It is an autonomous system that is self-controlled and self-managed.
- An energy microgrid provides users thermal energy for heating and cooling in addition to electricity.
- A fundamental feature of a microgrid is that it can operate either in grid-connected or islanded mode.
- In the grid-connected mode, the microgrid exchanges electrical energy with the bulk power grid.

Microgrid Components



BACKGROUND

Advantages

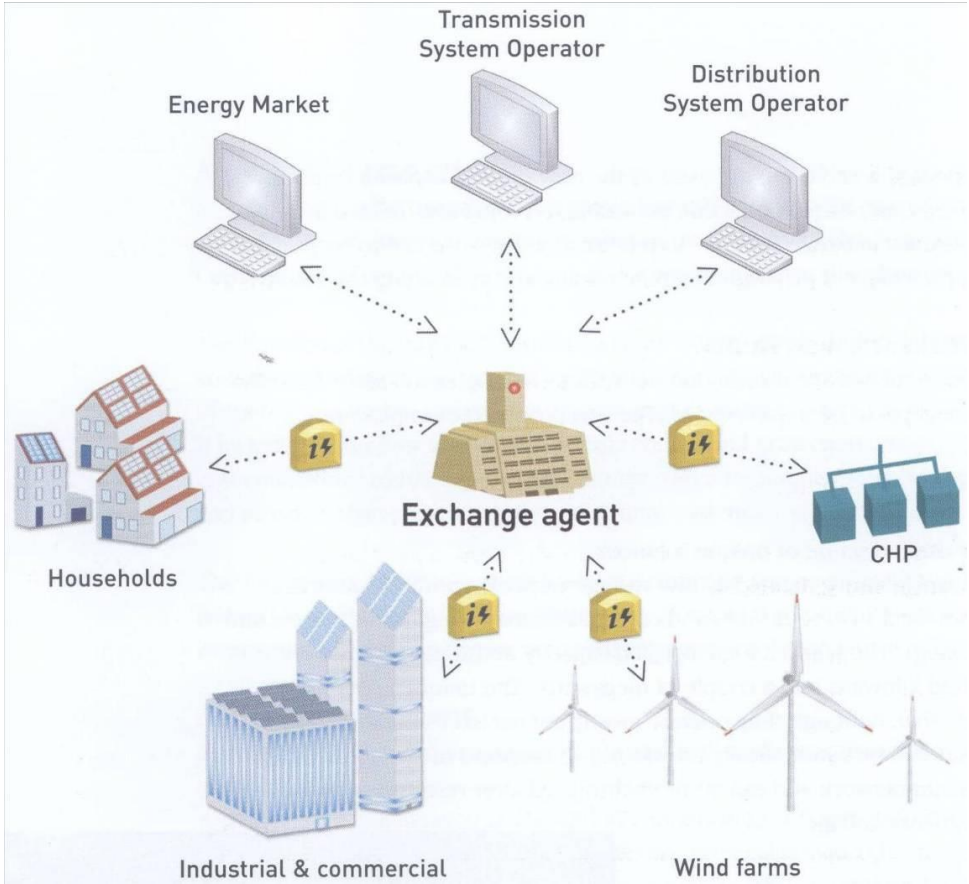
- Ability to connect multiple and diverse loads.
- The capability of islanding and operating independently from the grid seamlessly.
- Disconnection/ reconnection of loads, and DER's with minimal disruption the local loads.
- Provides reliability, and power quality benefits which are not available from the conventional utility grid system.
- Incorporates communication/aggregation features which allow organization, and control of the microgrid power system as a single entity.

MOTIVATION

- In order to achieve maximum power and good power quality for grid-connected PV power system, AI controller-based maximum power point tracking (MPPT) algorithm has been investigated as well as cascade multilevel inverter (MLI) is implemented for grid integration of PV system.
- The cascade MLI has been designed with a smaller number of power electronic switches and it can be operated at asynchronous voltage sources, which is most adaptable for PV system.
- This inverter can reduce the total harmonic distortion (THD) at output side by means of increasing the output voltage level and improving the power quality of the system.
- The microgrid integration of inverter can be controlled by using AI-based voltage source controller and this system is designed and simulated in MATLAB environment at various weather conditions and loading conditions.

CHALLENGES

- Frequency and voltage control
- Cybersecurity threats
- Limited capacity
- Control technology
- Battery cost
- Utility owners
- Expensive (high capital cost)
- Maintenance cost

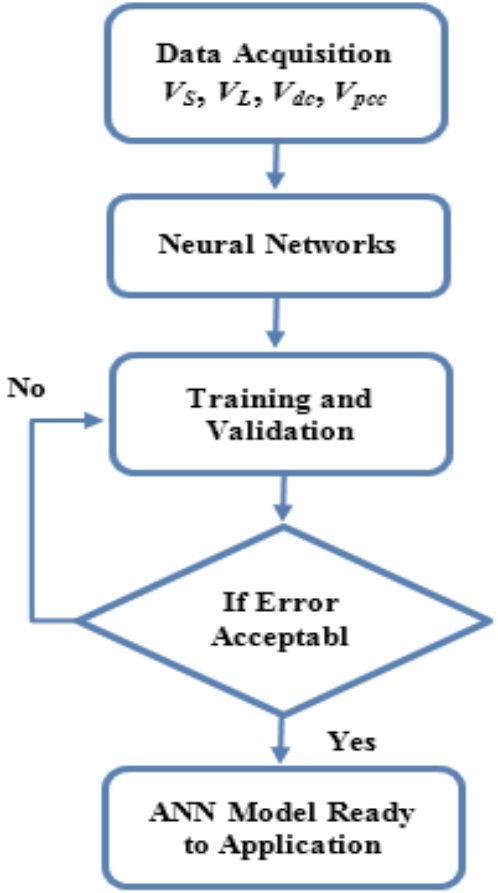


METHODS

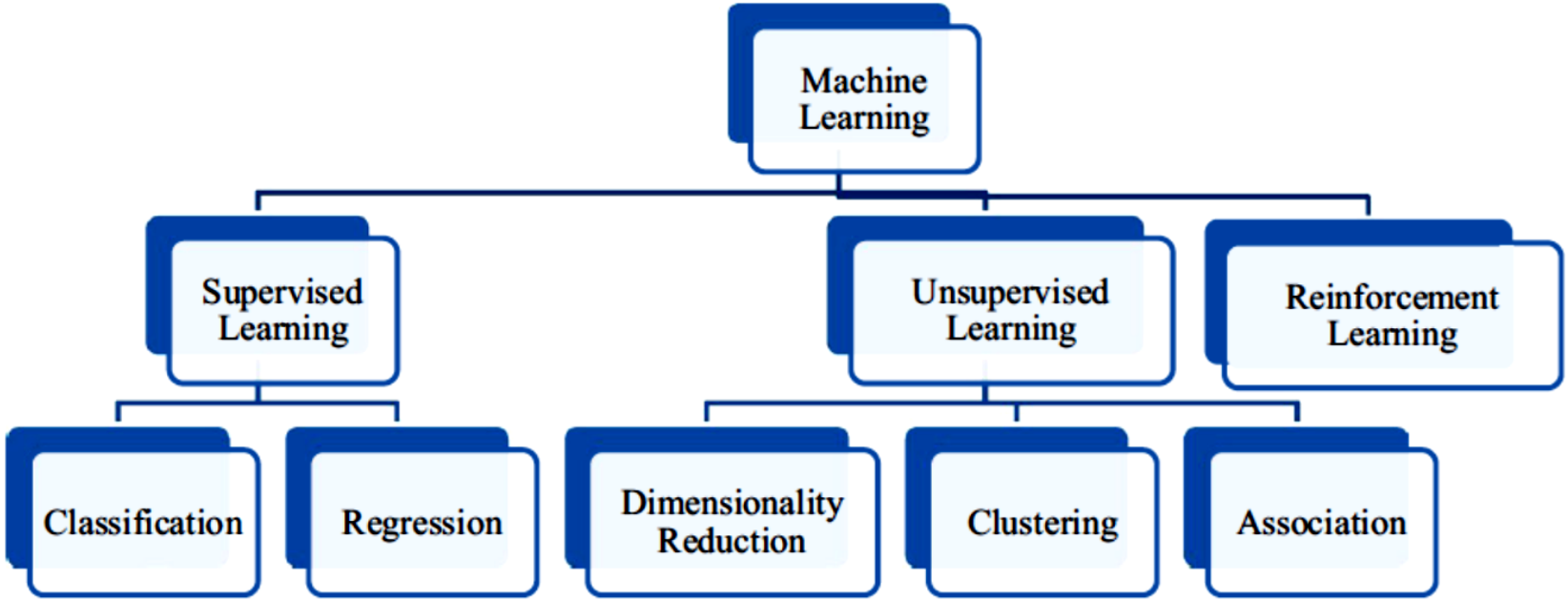
This project mainly focuses on AI-MPPT Controller for PV system and improves the power quality by reducing the THD in output.

The fuzzy based controller with ANN is modeled and simulated for the MPPT system for the PV and analyzed its performance under various weather conditions.

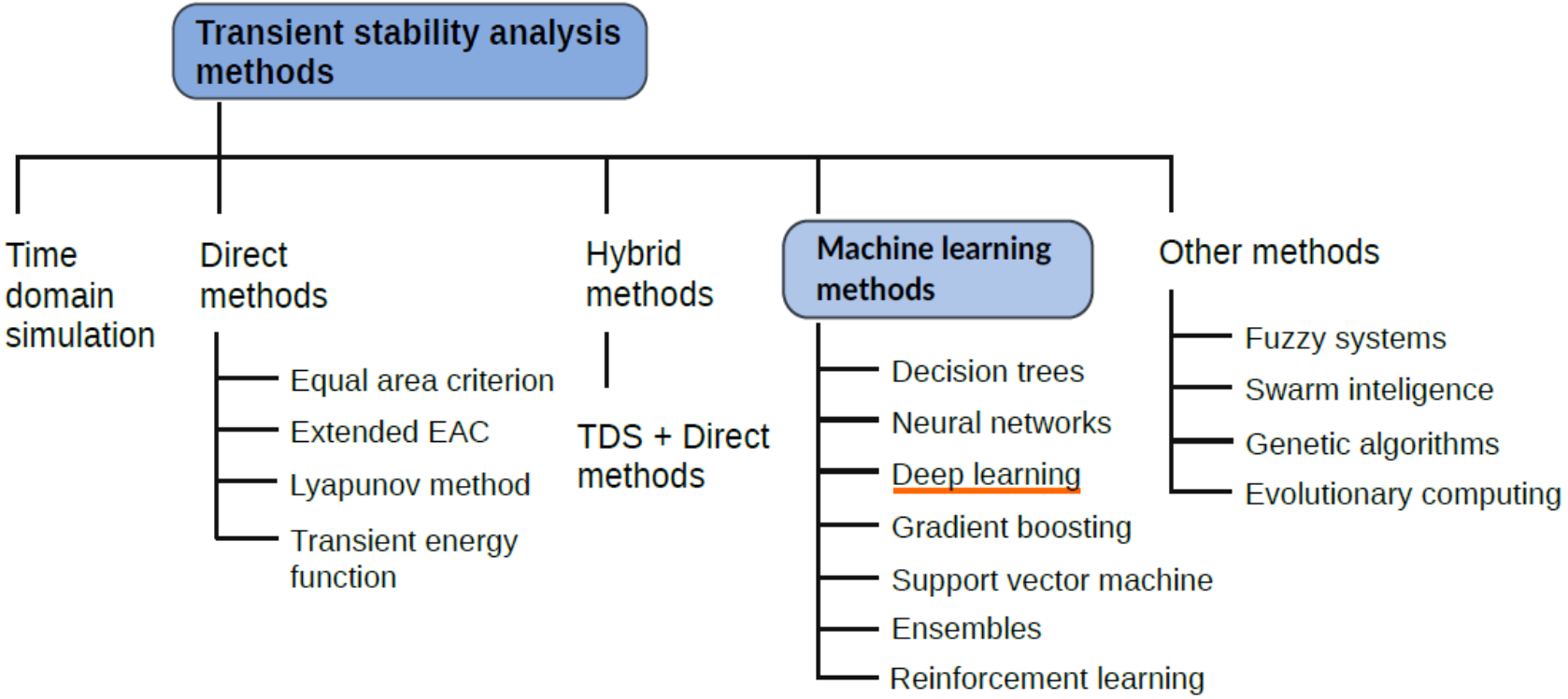
The grid integration of PV using cascade inverter has been simulated in MATLAB and results have been illustrated in detail.



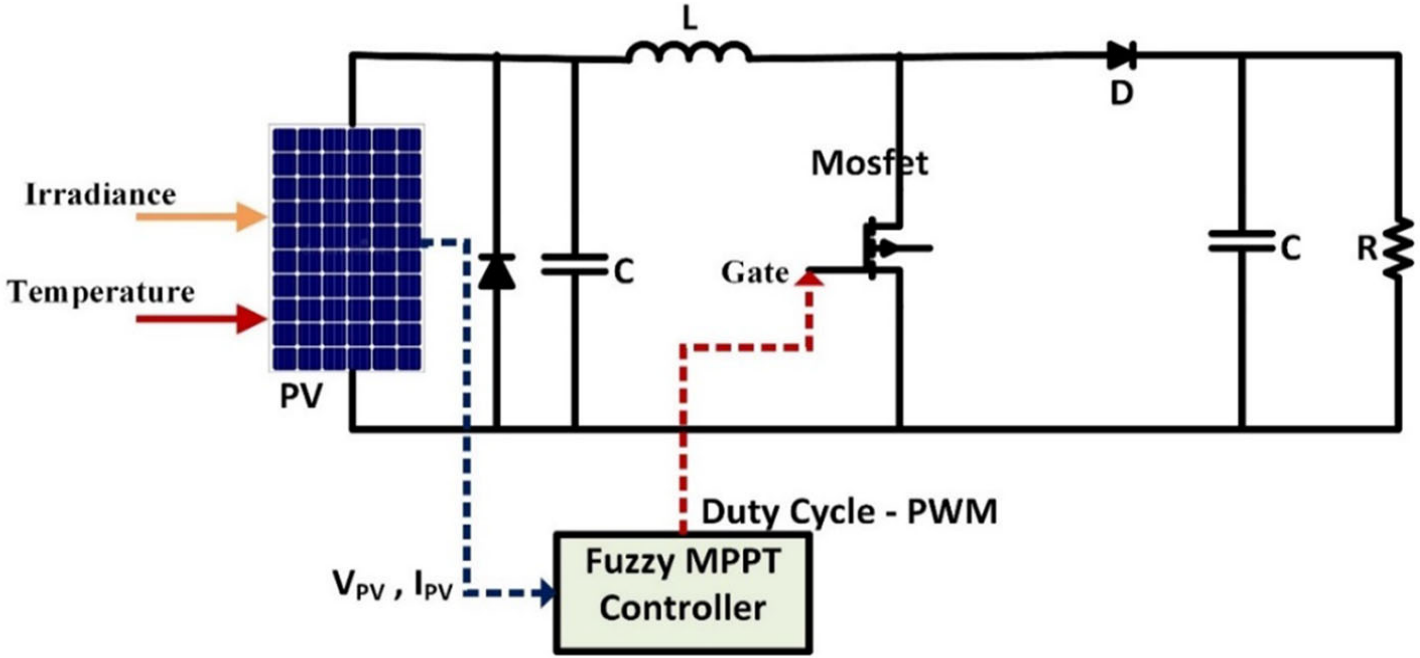
Categorization of Machine learning techniques



Power System Transient Stability Analysis with Machine Learning



MPPT with fuzzy algorithm for PV system—controller block diagram

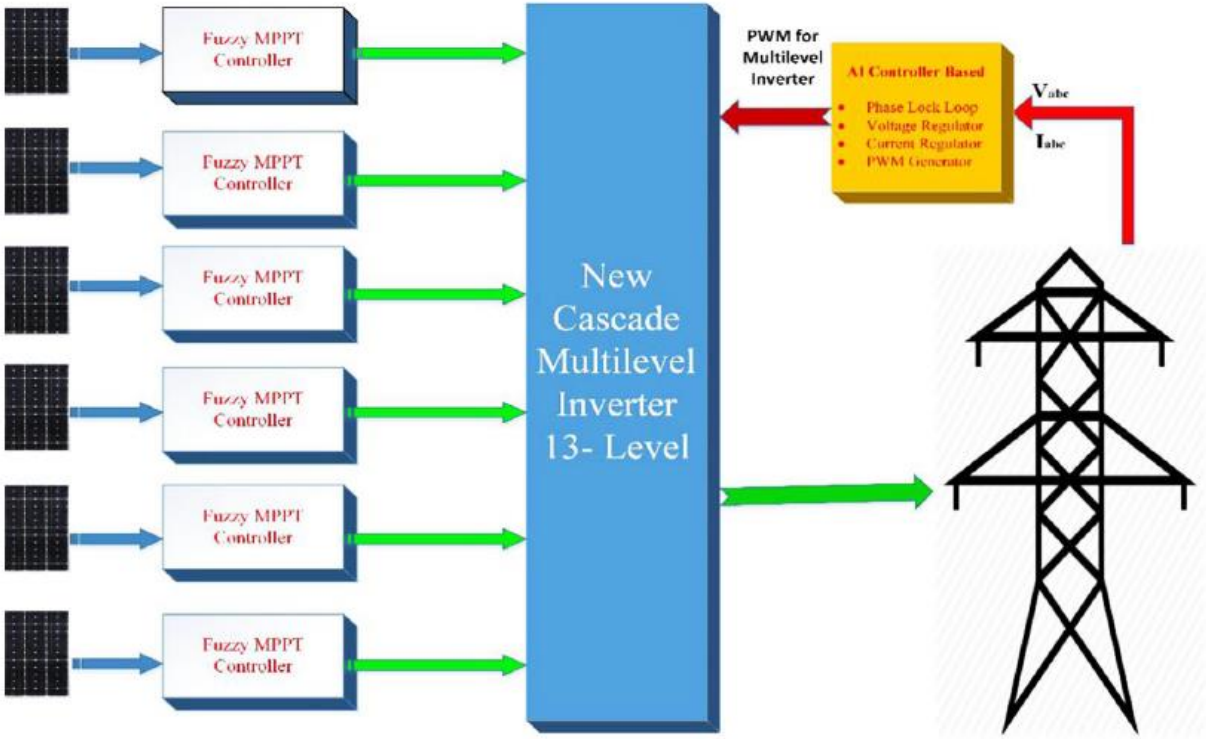


Artificial Intelligence-based MPPT Algorithm for PV system

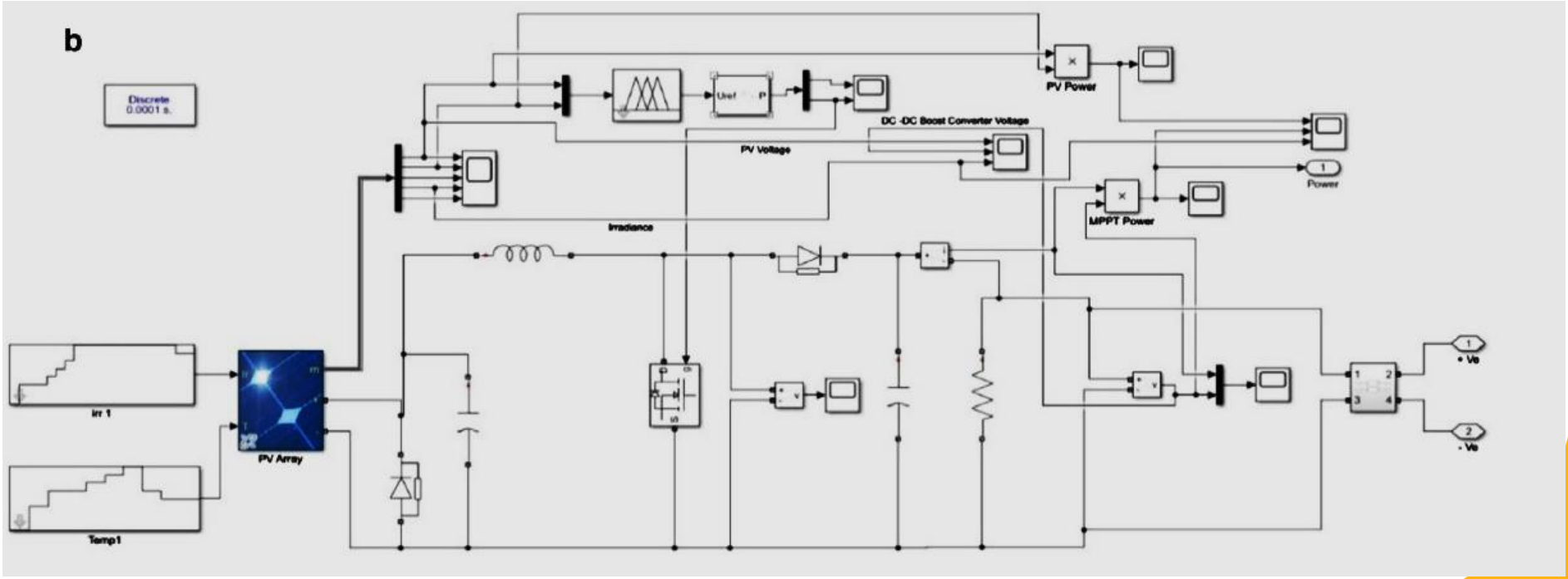
- The MPPT with fuzzy controller is designed for 30 kW PV in MATLAB Simulink model.
- In this simulation model 30 kW PV array has developed and it has two input sources such as solar irradiance and temperature.
- The 30 kW PV array is connected into boost converter with fuzzy based MPPT controller, to produce the duty cycle for the converter.
- The PV system output has been supplied to MPPT with fuzzy controller for analysis and generates the stable PV output power adapting to various irradiance conditions.

METHODS

Grid Integration of Cascade Multilevel Inverter for PV system and its Controller

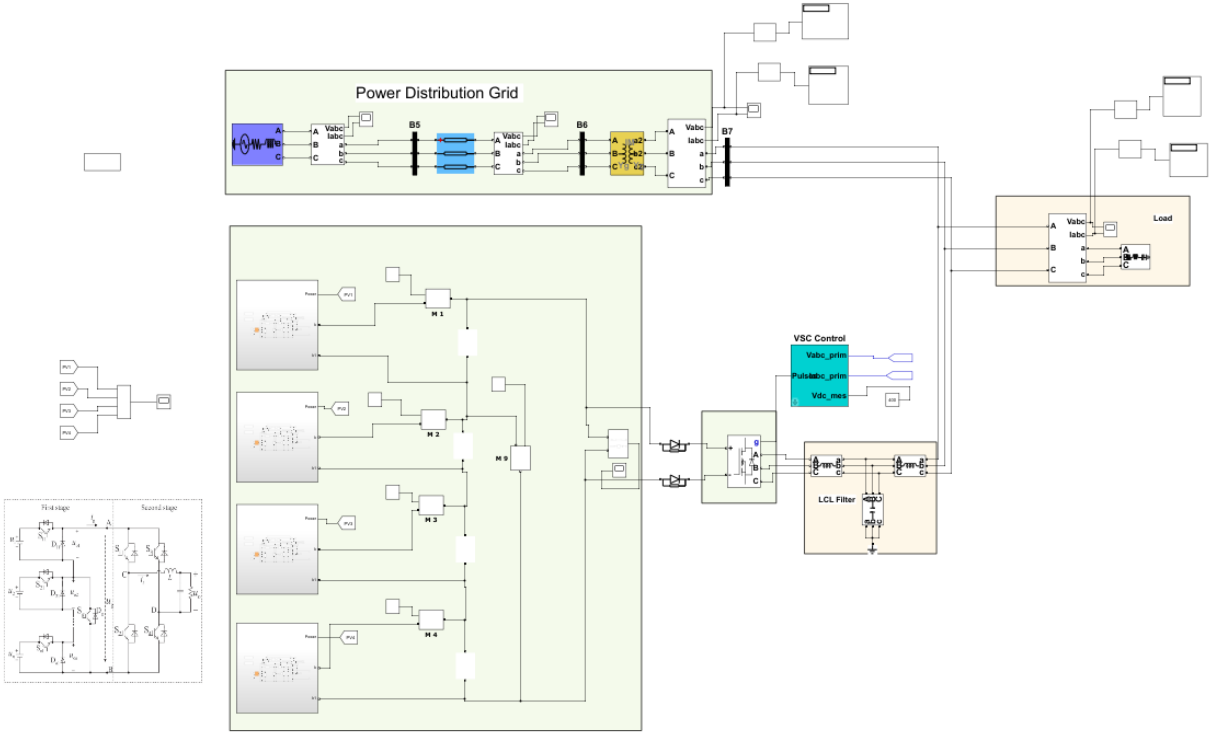


MPPT with fuzzy algorithm for PV system—MATLAB design

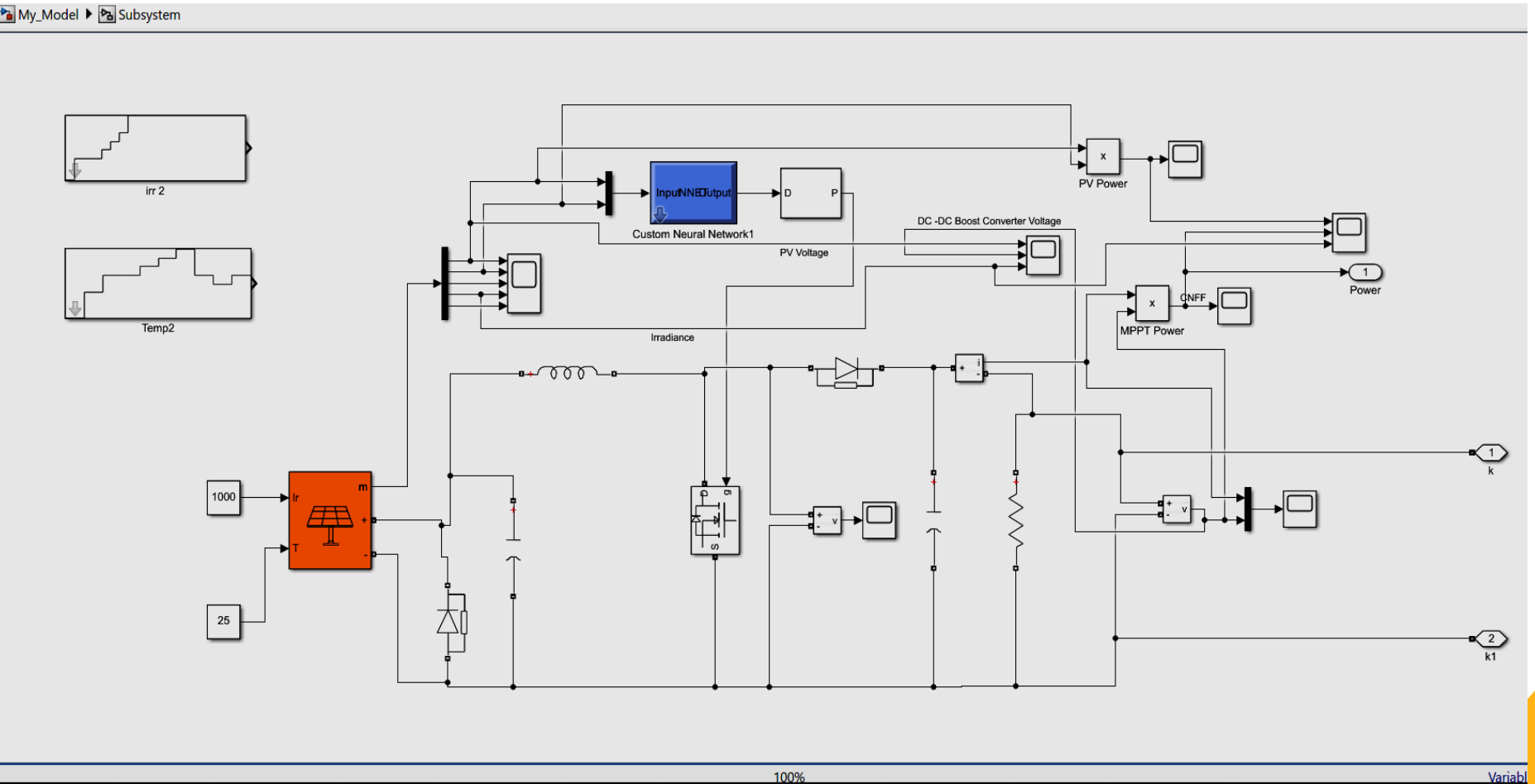


METHODS

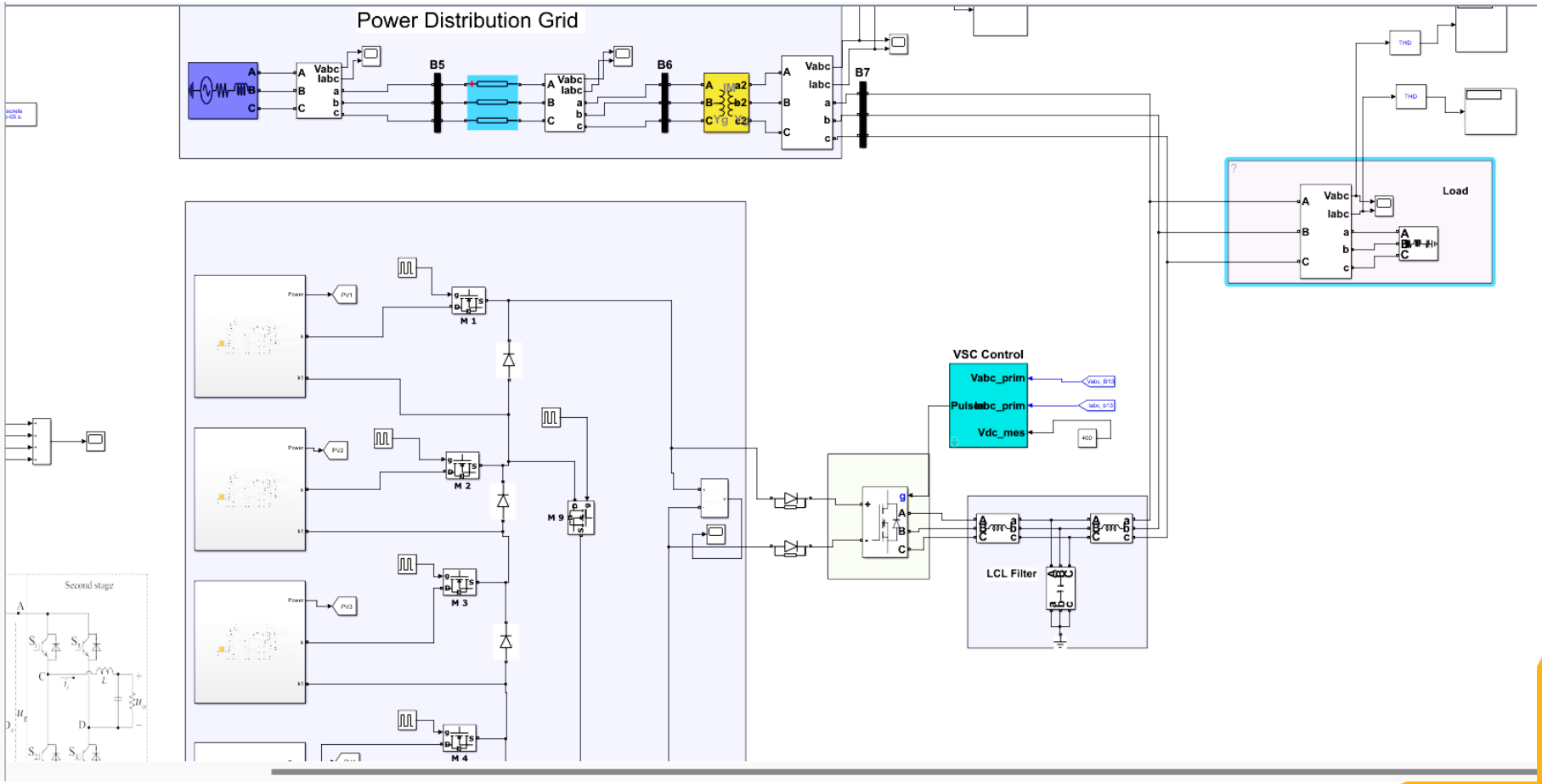
Machine Learning Algorithm-Based Grid Integration of Photovoltaic System



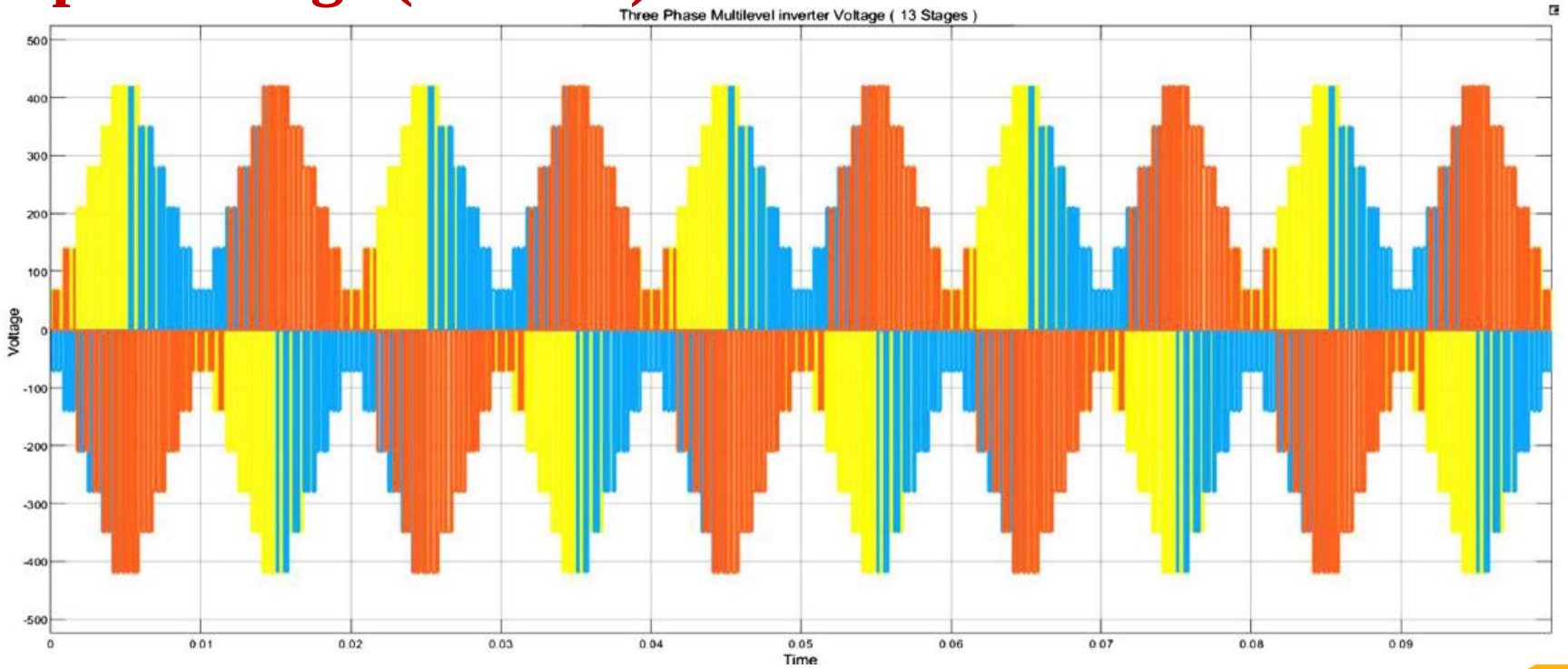
METHODS


My_Model
Subsystem
irr 2
Temp2
Custom Neural Network1
PV Power
PV Voltage
DC -DC Boost Converter Voltage
Irradiance
MPPT Power
Power
1000
25
k
k1
100%

METHODS

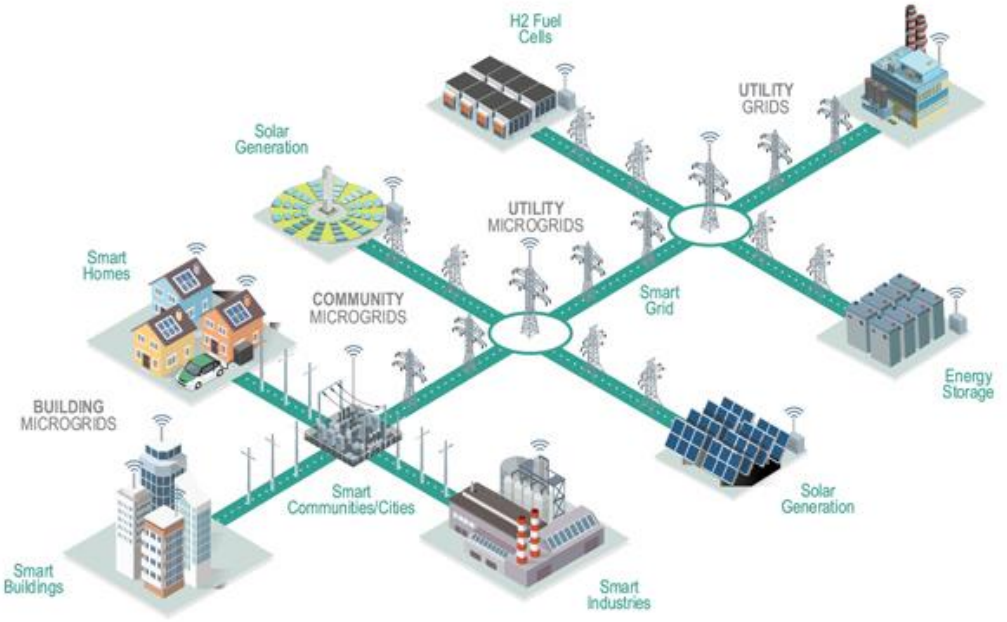

Power Distribution Grid
B5
B6
B7
Load
VSC Control
Vabc_prim
Pulses
Iabc_prim
Vdc_mes
LCL Filter
M 1
M 2
M 3
M 4
M 9
Second stage

New cascade multilevel inverter for proposed PV system output voltage (13 level)



FUTURE SCOPE

- An optimized control strategy
- Improved system reliability
- Hybrid microgrid
- Improved protection system
- Develop a novel communication system technology
- Energy Management System for Microgrid that control microgrid



CONCLUSION

- The role of microgrid in the smart grid advancement is crucial.
- This technology is not yet mature and still under testing stage.
- There are huge variety of microgrid systems.
- However, the acceptance of microgrid technology and the progression of this technology stalled due to various reasons: utility acceptance, high capital cost, exposure to cyber security threat, the underdeveloped energy storage technology, complex control strategy and integration of the micro-sources (DG).
- Need better control of grid operation transition for a continuous power.
- Control strategy for an optimal integration of Distributed Energy Resource (DG and DS) into utility grid.

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