IJMTARC – VOLUME – IX – ISSUE – 36, OCT - DEC, 2021

ISSN: 2320-1363

ENERGY MANAGEMENT AND ISLANDING DETECTION BASED ON LIFTING WAVELETS FOR HYBRID SMARTGRID

J.MARTINA RUBAVATHI[1], M.VENKATESH[2]

[1]PG Scholar, Department of Electrical and Electronics, Priyadarshini Engineering College, Vaniyambadi.

[2]Asst. Professor, Department of Electrical and Electronics, Priyadarshini Engineering College, Vaniyambadi.

ABSTRACT

This project proposes a novel method of lifting wavelet based abnormality detection to decide the decision of islanding is needed or not in smart grids where an integrated renewable and non-renewable energy sources are utilized.

Using lifting wavelet transforms always results in time localization and hence the instant of islanding also can be detected with our proposed method.

The problem of micro grid is its discontinuity in the power delivery based on the available power. This is a serious problem in power delivery.

A Simulink model consisting of a distributed generator and the main power grid based generator is designed and faults are created at random times.

In such conditions, islanding is needed to protect the loads, grids and even to maintain the continuity in the power delivery

In this paper, a robust optimal PMS (ROPMS) is developed for a hybrid ac/dc micro-grid, where the power flow in the micro-grid is supervised based on solving an optimization problem using neural network. Satisfying demanded power with maximum utilization of renewable resources, minimum usage of fuel-based generator, extending batteries lifetime, and limited utilization of the main power converter between the ac and dc micro-grids are important factors that are considered in this approach. In case of demand more than generation, a control system performs to meet the demand by employing power tracking algorithms. Simulation is done using MATLAB tool boxes.

INTRODUCTION

Nowadays, because of high penetration levels of renewable energy resources, the paradigms of microgrids (MGs) and distribution generation (DG) are gaining vital role in power and distribution systems. MGs are categorized as ac MGs, dc MGs, and hybrid ac–dcMGs. Since a considerable portion of renewable energy resources, such as wind turbines, photovoltaic (PV), fuel cells and energy storage systems, and many modern loads such as communication technology facilities, data centers, and motor drives is dc-type, dynamics and controls of rectifiers and dc MGs are gaining high interest [1]. However, in dc grids, many generation units such as wind turbines must be interfaced to the utility grid via electronically interfaced (EI) rectifiers. In addition, several modern ac loads are coupled to ac grids through back-to-back rectifier-inverter to provide variable frequency operation. Based on predictions given in [2], the resistive load share will be significantly reduced whereas the EI loads share will increase to 60-80% of the total load by 2015.

The conventional control topologies for three-phase converters are the voltage-oriented vector control [3] and direct- power control [4]. The dq components of the current vector are regulated by a controller generating appropriate values for the converter dq voltage components. A phase locked-loop (PLL) is required to transform current and voltage variables from the abc frame to the dq frame. It is also feasible to implement the controller in the stationary frame or the abc frame using a proportional-resonant (PR) controller [5]. An alternative control strategy is to use direct power control in which voltage components are adjusted based on active and reactive power errors. None of these methods, however, can directly control the frequency and the load angle. One of the major challenges facing future power systems is significant reduction in grid equivalent rotational inertia due to the expected high penetration level of EI units, which in turn may lead to frequency-stability degradation. To overcome this difficulty, controlling VSCs as virtual synchronous machines is proposed for power system frequency stabilization [6] by embedding a short-term energy storage to the VSC facilitating power flow to and from to the energy storage device proportional to the variation in grid frequency. In [7], the idea of synchronverter was addressed to emulate the mechanical behavior of a synchronous generator (SG) in inverters. However, the dc-link is considered

IJMTARC – VOLUME – IX – ISSUE – 36, OCT - DEC, 2021

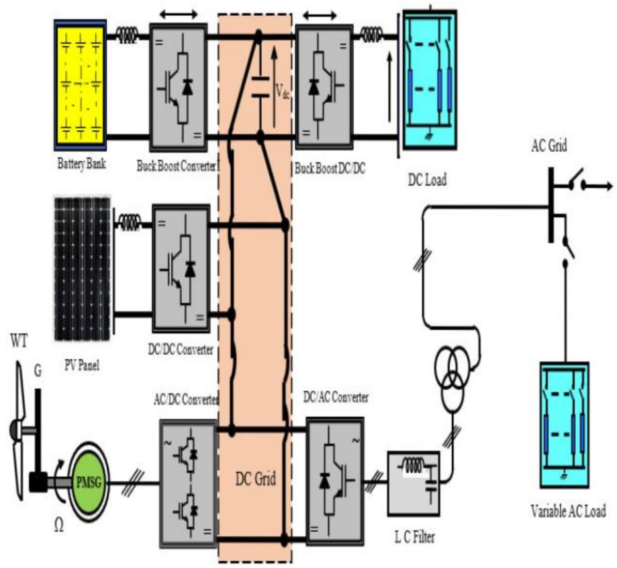
ISSN: 2320-1363

as an ideal one with infinite energy and the dynamics of dc-link voltage is not considered.

Moreover, its application to rectifiers has not been addressed. In [8]–[10], methods to emulate virtual inertia in VSCs interfacing wind turbines and HVDC systems, are presented; however, the embedded inertia does not emulate the behavior of an SG. The analogy between voltage-source inverters and SG-based MGs has also been addressed in [11], [12]. The aforementioned survey indicates the interest in developing new and improved control algorithms for VSCs to emulate the dynamic behavior of SGs.

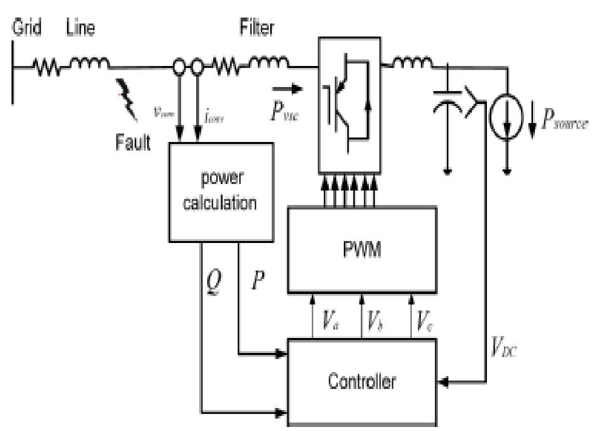
Beside overall low inertia, future power systems and MGs will suffer from interactions between fast responding VSCs and slower SMs which may contribute to angle, frequency, and voltage instability [13]. With the expected high penetration level of power converters in future power grids, a power system may face severe difficulty in terms of frequency regulation because of lack of rotational inertia in converter-interfaced generators. Another challenge is that frequency dynamics are not known in the conventional control techniques of VSCs (e.g., voltage-oriented control and direct-power control) which makes it difficult to analyze the angle and frequency stability of a system containing several EI units and conventional synchronous machines (SMs) and line-start motors. Therefore, the development of VSCs with well-defined angle, frequency, and dc-link voltage characteristics (similar to SMs with extension to dc-link dynamics) are of high interest for future smart power systems with a high penetration of VSCs. Moreover, a general control scheme which is suitable for both rectification and inversion modes without reconfiguration is very attractive in power system applications since bidirectional VSCs can work in generative and motoring modes similar to SMs.

EXISTING SYSTEM



The present system consists of ac and dc grid systems. Both equipped with a bidirectional ac to dc converter. This enables the loads to bet power supply irrespective of shortage in power, with some constraints.

CONTROLLER DESIGN



$$\frac{\Delta\delta}{\Delta P} = \frac{\xi\omega_n}{s^2 + 2\xi\omega_n s + \omega_n^2}$$

ISSN: 2320-1363

where $\omega_n = \sqrt{K_d/J}$ and $\xi = K_f\sqrt{JK_d}/2$. Consequently, for a desired bandwidth and damping ratio ω_n and ξ, the control parameters can be obtained. The controller natural frequency (ω_n) should be chosen much smaller than the switching frequency (ω_s). Another concern related to ω_n is the system rise time. Usually, the most inner controller bandwidth is selected to be less than 20% of the switching frequency. Unlike real SMs, the rotational momentum and friction factor can be selected equal to values that are not possible for physical electrical machines. The larger J means the higher stored energy; however, to provide this energy, more short-term energy storage or equivalently

The lower the gain , the lower the frequency time-constant is. Nevertheless, it may lead to a steady-state error in the output. If the extra phase angle shift is removed, the transfer function is reduced to

$$\frac{\Delta\omega}{\Delta V_{DC}^2} = \frac{1}{\tau_f s + 1} \quad \tau_f = \frac{J}{K_f}$$

To calculate frequency recovery time-constant,

$$\frac{\Delta V_{DC}^{2*}}{\Delta\omega} = -K_d\left(\frac{1}{T_i s} + 1\right),\ T_i = \frac{1}{K_f}$$

Lower values of results in faster response at the cost of higher steady-state error. can be adjusted by the usual phase margin criterion.

Simulated parameters of existing work

TABLE I
SIMULATED SYSTEM PARAMETERS (SI UNITS)

Parameter	Value
Line inductance	4 mH
Line resistance	0.3 Ω
Grid L-L voltage	220 v
Switching frequency	8kHz
Filter inductance	1 mH
Filter resistance	0.1 Ω
DC side capacitor	2 mF
DC side inductance	0.2 mH
Virtual rotor momentum (J)	10
K_q	0.0001
K_d	1000
K_f	10
K_{qi}	0.00025
τ_v	0.005
ω_c	200 (rad/s)

RMS CURRENT MODEL OF DEVICES IN DAB CONVERTER FOR BUCK MODE
(POWER TRANSFER FROM THE HV SIDE TO THE LV SIDE)

Device	RMS current equation
HV side Transistor	$I_{RMS}=\sqrt{\frac{1}{T_S}\left[\frac{(I_{L1})^2}{3}\times\left(\frac{dT_S}{2}-t_B\right)+\left(\frac{T_S}{2}-\frac{dT_S}{2}\right)\left(I_{L1}^2+\frac{I_r^2}{3}+I_{L1}I_r\right)\right]}$
HV side Diode	$I_{RMS}=\sqrt{\frac{1}{T_S}\left[\frac{I_P^2}{3}\times(t_B)\right]}$
LV side Transistor	$I_{RMS}=\sqrt{\frac{1}{T_S}\left[\frac{(I_{L1})^2}{3}\times\left(\frac{dT_S}{2}-t_B\right)\right]}$
LV side Diode	$I_{RMS}=\sqrt{\frac{1}{T_S}\left[\left(\frac{T_S}{2}-\frac{dT_S}{2}\right)\left(I_{L1}^2+\frac{I_r^2}{3}+I_{L1}I_r\right)+\frac{(I_P)^2\times t_B}{3}\right]}$

IJMTARC – VOLUME – IX – ISSUE – 36, OCT - DEC, 2021

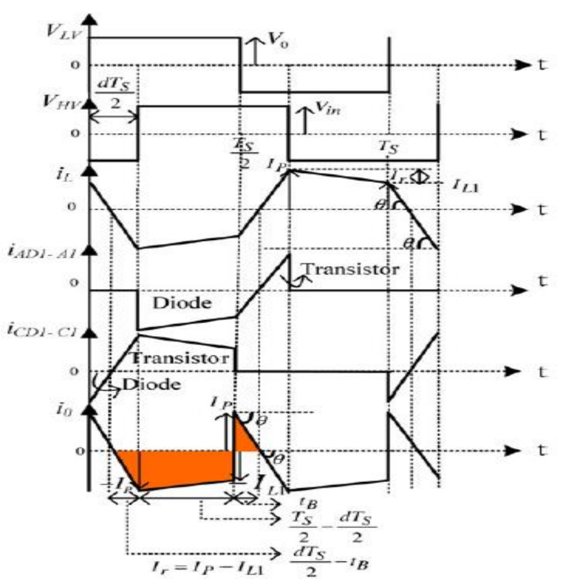
ISSN: 2320-1363

$$I_{\text{rms}} = \sqrt{\frac{2}{T_S}\int_0^{T_S/2} I^2(t)dt}.$$

AVERAGE CURRENT MODEL OF DEVICES IN DAB CONVERTER FOR BUCK MODE (POWER TRANSFER FROM THE HV SIDE TO THE LV SIDE)

Device	Average current expression
HV side Transistor	$I_{avg}=\frac{\frac{1}{2}\times I_{L1}\times\left(\frac{dT_S}{2}-t_B\right)+\frac{1}{2}\times(I_{L1}+I_P)\times\left(\frac{T_S}{2}-\frac{dT_S}{2}\right)}{\frac{T_S}{2}-t_B}$
HV side Diode	$I_{avg}=\frac{\frac{1}{2}\times I_P\times t_B}{t_B}$
LV side Transistor	$I_{avg}=\frac{\frac{1}{2}\times I_{L1}\times\left(\frac{dT_S}{2}-t_B\right)}{\left(\frac{dT_S}{2}-t_B\right)}$
LV side Diode	$I_{avg}=\frac{\frac{1}{2}\times(I_{L1}+I_P)\times\left(\frac{T_S}{2}-\frac{dT_S}{2}\right)+\frac{1}{2}\times I_P\times t_B}{\left(\frac{T_S}{2}-\frac{dT_S}{2}+t_B\right)}$

OPERATING WAVEFORMS



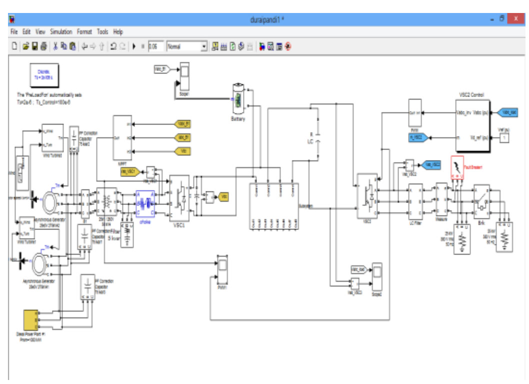
PROPOSED SYSTEM

The proposed circuit deals with the full bridge coupled through a transformer to full bridge rectifier with the pwm pulses applied to them. This system gives a better conversion efficiency is to be proved in simulation done in matlab 7.10 . The proposed PMS is designed to maximize the profit of sold power. A PV/battery micro-grid is considered, and an optimization-based PMS is proposed mainly to minimize the energy bill of the owner of the system. An ANN optimization-based PMS for the hybrid ac/dc micro-grid is proposed, in order to achieve a robust, efficient, and optimal power flow in the hybrid micro-grid. Our goal is to satisfy demanded power and control the power exchange between the micro-grids, while trying to achieve maximum utilization of renewable resources, minimum usage of fuel-based generator, extending batteries lifetime, and limited utilization of the main power converter between the ac and dc micro-grids.

OUTPUTS

FORWARD AC GRID SIDE

Simulink model

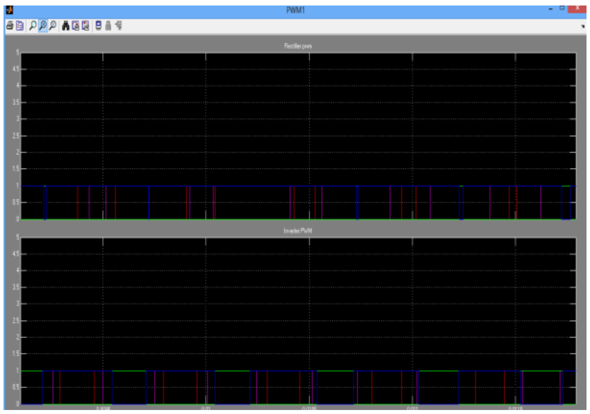


The above Simulink model shows the power generation using wind, diesel in the forward direction. The power generated is converted into DC and the same is stored in the form of DC in a backup battery. The bidirectional DC-DC converter allows the power flow in both the directions. Hence, either Ac grid or DC grid would get power based the power demand and the availability.

IJMTARC – VOLUME – IX – ISSUE – 36, OCT - DEC, 2021

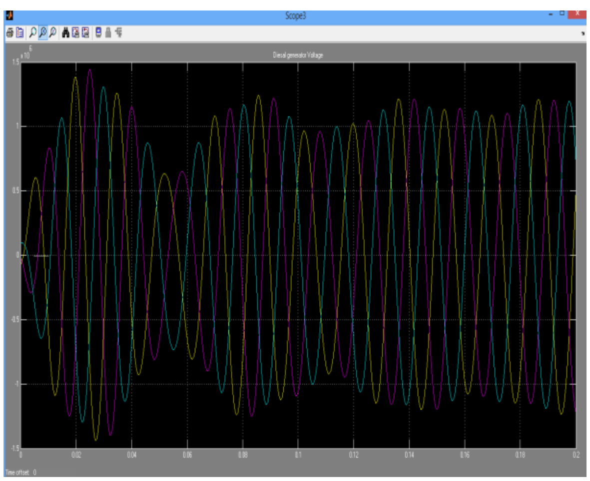
ISSN: 2320-1363

PWM PULSES



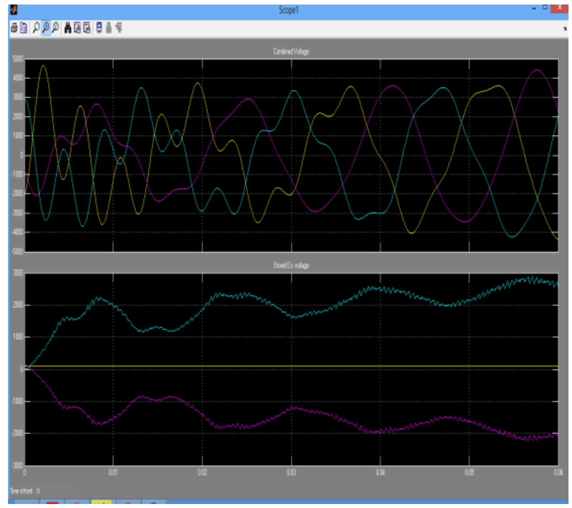
X axis – time in sec
Y axis – Voltage amplitude (pulse amplitude of 0 V to 1 V)
These pulses are applied to 6 switches of three arms constructed using MOSFETs.

ONLY FROM DIESEL GENERATOR

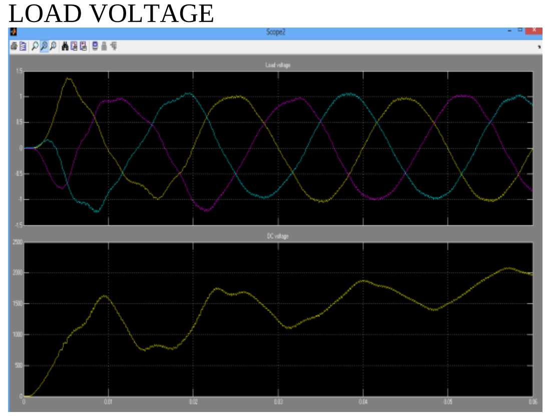


The Stability takes at least 0.14 s to settle down. After that the diesel generator produces a constant voltage and hence the constant power.
X axis – time in sec
Y axis – Voltage amplitude

GENERATED VOLTAGE AND DC STORED VOLTAGE



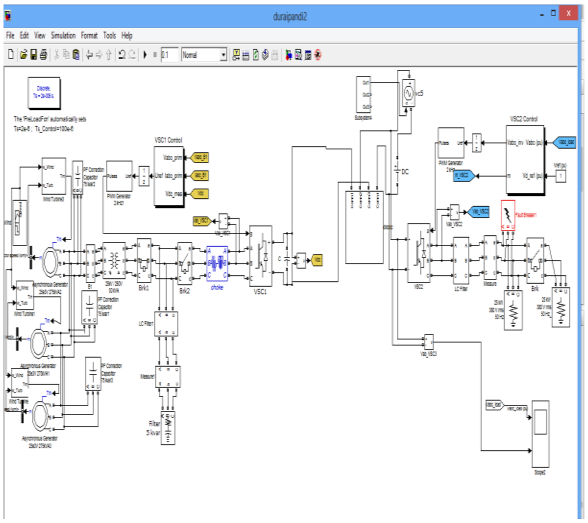
This output shows the three phase voltage generated from a combined diesel and wind source along with the DC voltage stored in the battery at DC side. The settling of voltage waves to stable values takes at least 0.05 s to give a stable voltage.
LOAD VOLTAGE



X axis – time in sec
Y axis – Voltage amplitude
This output shows the three phase voltage at a three phase load supplied from a combined diesel and wind source along with the DC voltage stored in the battery at DC side. The settling of voltage waves to stable values takes at least 0.05 s to give a stable voltage.

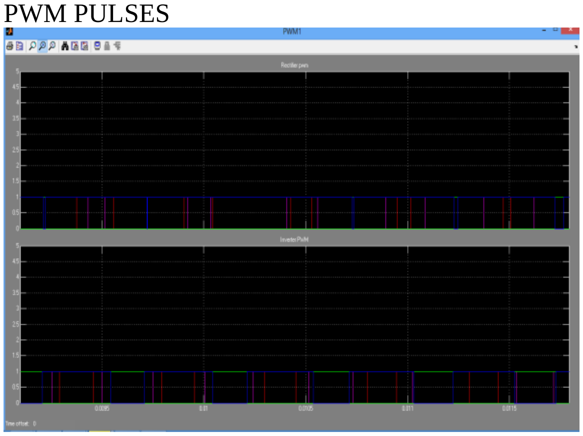
OUTPUTS IN DC GRID SIDE

SIMULINK OF DC GRID SIDE



The above model shows the reverse power flow from DC to AC side. Where the breakers are programmed to allow only the DC power and blocks the AC power to the load placed at the AC grid side. The power generated from solar panels and already stored in the batteries are transmitted in reverse direction via a bi directional dc-dc converter and hence that is inverted and supplied to the three phase load after a proper LC filter to convert into a pure sine wave.

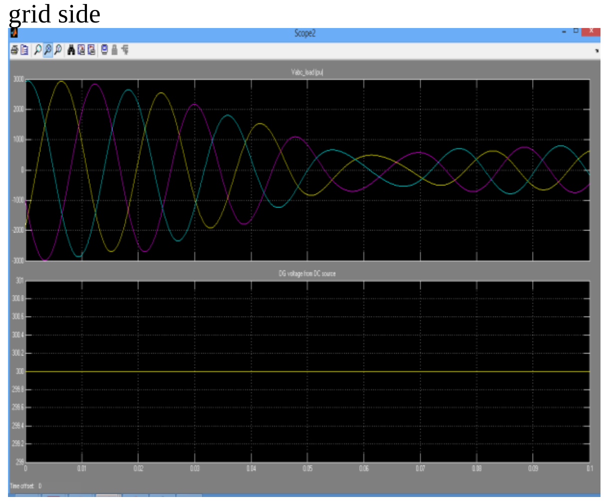
PWM PULSES



X axis – time in sec

Y axis – Voltage amplitude (pulse amplitude of 0 V to 1 V)

These pulses are applied to 6 switches of three arms constructed using MOSFETs. The pulses remain the same in both forward and reverse is the feature of our work. Load voltage at AC side and DC voltage at DC grid side



X axis – time in sec

Y axis – Voltage amplitude

This output shows the three phase voltage at a three phase load supplied from DC grid along with the DC voltage stored in the battery at DC side. The settling of voltage waves to stable values takes at least 0.07 s to give a stable voltage. The settling time depends on the controller efficiency. The DC voltage shown in the figure is the summation of the solar panel and the battery voltage.

MERITS

The proposed system, detects the time instant such fault, and hence any analysis in future can be done well with wavelet transforms.

The system is able to maintain the power delivery to the load, without any interruptions even in the case of power discretion or shortage of power.

CONCLUSION

In this project, in this tenure of phase1, an isolated hybrid ac/dc microgrid is proposed to satisfy power demand in both the ac and dc micro-grids. The optimal power flow for the hybrid ac/dc micro-grid is assessed through minimizing a cost function along with some operational constraints. In this project, a two-level control scheme is utilized in order to determine charge/discharge power of the battery banks and regulate the voltage level. Since generation forecast errors may severely affect the obtained optimal solution, a robust formulation is used to treat these uncertainties. Power imbalances caused by

IJMTARC – VOLUME – IX – ISSUE – 36, OCT - DEC, 2021 ISSN: 2320-1363

uncertainties in the resources output power, can change the voltage level of dc bus in the dc micro-grid, and bus DC in the ac micro-grid.

REFERENCES

[1] H. T. Dinh, J. Yun, D. M. Kim, K. Lee, and D. Kim, ``A home energy management system with renewable energy and energy storage utilizing main grid and electricity selling," *IEEE Access*, vol. 8, pp. 4943649450, 2020.
[2] C. Byers and A. Botterud, ``Additional capacity value from synergy of variable renewable energy and energy storage," *IEEE Trans. Sustain. Energy*, vol. 11, no. 2, pp. 11061109, Apr. 2020.
[3] M. Rizwan, L. Hong, W. Muhammad, S. W. Azeem, and Y. Li, ``Hybrid Harris Hawks optimizer for integration of renewable energy sources considering stochastic behavior of energy sources," *Int. Trans. Elect. Energy Syst.*, vol. 31, no. 2, 2021, Art. no. e12694, doi: 10.1002/20507038.12694.
[4] Y. Sun, Z. Zhao, M. Yang, D. Jia,W. Pei, and B. Xu, ``Overview of energy storage in renewable energy power uctuation mitigation," *CSEE J. Power Energy Syst.*, vol. 6, no. 1, pp. 160173, 2020.
[5] T. Salameh, M. A. Abdelkareem, A. G. Olabi, E. T. Sayed, M. Al-Chaderchi, and H. Rezk, ``Integrated standalone hybrid solar PV, fuel cell and diesel generator power system for battery or supercapacitor storage systems in khorfakkan, united arab emirates," *Int. J. Hydrogen Energy*, vol. 46, no. 8, pp. 60146027, Jan. 2021.
[6] M. Çolak and Ä. Kaya, ``Multi-criteria evaluation of energy storage technologies based on hesitant fuzzy information: A case study for turkey,'' *J. Energy Storage*, vol. 28, Apr. 2020, Art. no. 101211.
[7] M. A. Hannan, M. M. Hoque, A. Mohamed, and A. Ayob, ``Review of energy storage systems for electric vehicle applications: Issues and challenges," *Renew. Sustain. Energy Rev.*, vol. 69, pp. 771789, Mar. 2017.
[8] R. Amirante, E. Cassone, E. Distaso, and P. Tamburrano, ``Overview on recent developments in energy storage: Mechanical, electrochemical and hydrogen technologies," *Energy Convers. Manage.*, vol. 132, pp. 372387, Jan. 2017.