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# FREQUENCY STABILIZATION OF ISOLATED AND GRID CONNECTED HYBRID MICROGRID MODEL

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**Abstract.** This study investigates load frequency control in hybrid power systems that are both isolated and connected to the grid (IHPS and GHPS). IHPS generating units, whereas GHPS generating units contain WTG and steam thermal power station integration (STPS). While the system is in isolated mode, superconducting magnetic energy storage (SMES) is used as the energy storage device. A typical proportional-integral (PI) controller is used to stabilise the load frequency and improve the system's dynamic performance. Using Mat lab Simulink, the transient response of the system to step changes in the load demand is investigated for IHPS and GHPS.

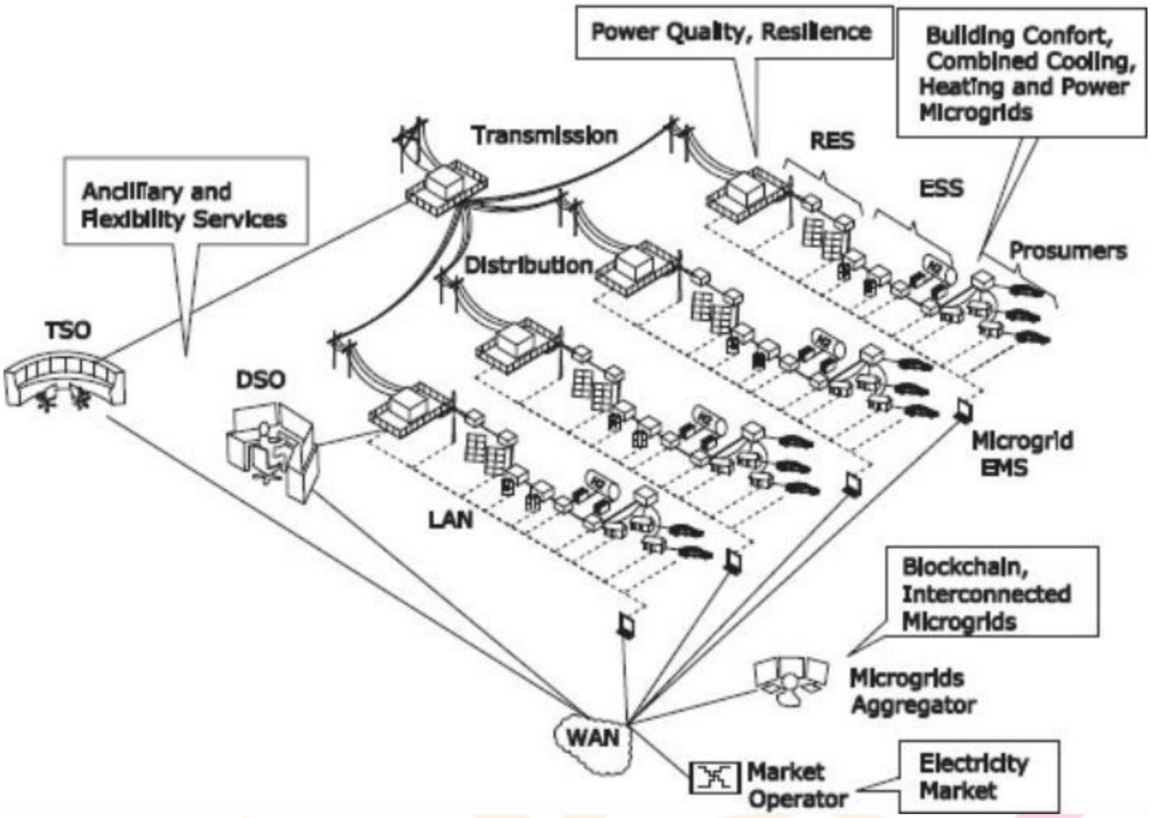
# INTRODUCTION

The preparation and activity of force frameworks should be adjusted to the non-simultaneous nature climate of future power frameworks where Renewable Energy Systems (RES) will be predominant, along these lines making it more inclined to recurrence insecurity in a setting where the vast majority of the subordinate administrations to give

lattice strength will essentially should be given by the RES of customer based assets, as opposed to in view of the idleness of customary generators. As characterized by CIGRE [1], microgrids are power dispersion frameworks containing loads and appropriated energy assets, (like conveyed generators, capacity gadgets, or controllable burdens) that can be worked in a controlled, composed way either while associated with the principle power network or when they function as islanded frameworks. From the power network's point of view, the conveyance of such aspiration requires the improvement of cost-proficient methodologies that answer the difficulties of reasonableness, intensity, security of supply, and manageability of electric power frameworks completely founded on environmentally friendly power frameworks. Microgrids can likewise build the strength, security,

what's more, savvy of the energy framework in an undertaking to advance towards an energy framework which is equipped for facilitating a huge portion of variable renewables. The adaptability given by energy capacity frameworks in microgrids, as well as the capacity of microgrids to work on matrix associated/islanded mode, show up as key answers for the difficulties presented by the future transmission and appropriation lattices. The change of the shrewd matrix towards a more organized framework in view of microgrids with capacity frameworks working in a helpful and self-coordinated manner shows up as a key to change our present energy framework into a more clever, strong, and greener one.

Expanding interest for electrical energy in the cutting edge world because of modern turn of events and sped up populace development has developed a flourishing interest in the reconciliation of sustainable power assets (RES) in power frameworks. RES like sun oriented energy, seaward wind, hydropower, sea energy, biofuels, and biomass bear the cost of efficient power energy and diminishes the reliance on petroleum products. A microgrid-based construction of the savvy framework wouldn't just permit better coordination of the arising circulated parts in the discount market however could likewise be used as a piece of dissemination and transmission framework the board through advancing adaptability (subordinate help) market and novel matrix the executives ideas. In most evolved nations, the arrangement structure for environment and energy follows the aggressive responsibility of diminishing ozone depleting substance emanations and arriving at a nonpartisan carbon-based energy framework in the following not many years. The presentation of microgrids could further develop unwavering quality, lessen emanations, and extend energy choices later on power framework.



.Fig 1 overview of main functionalities of micrograms

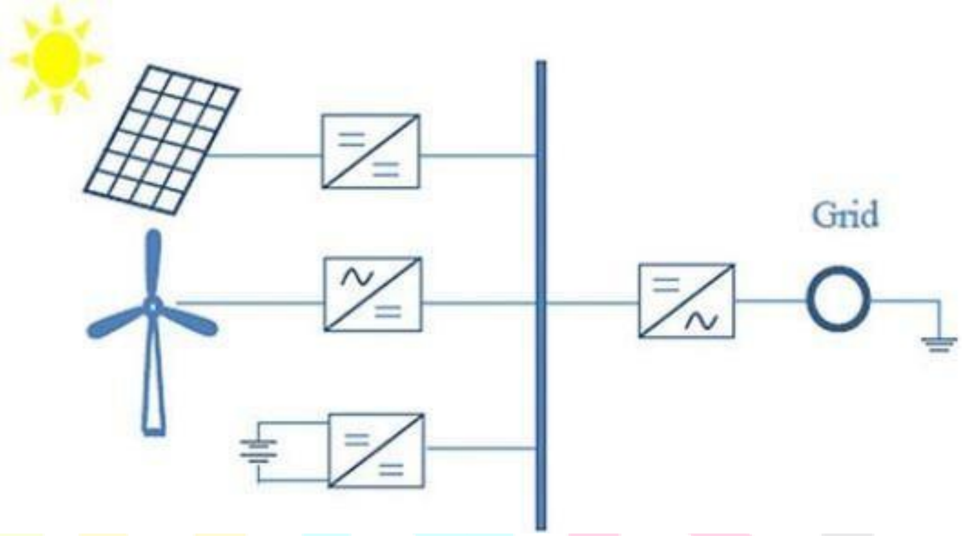


Fig 1.2 Grid connected hybrid system at common dc bus

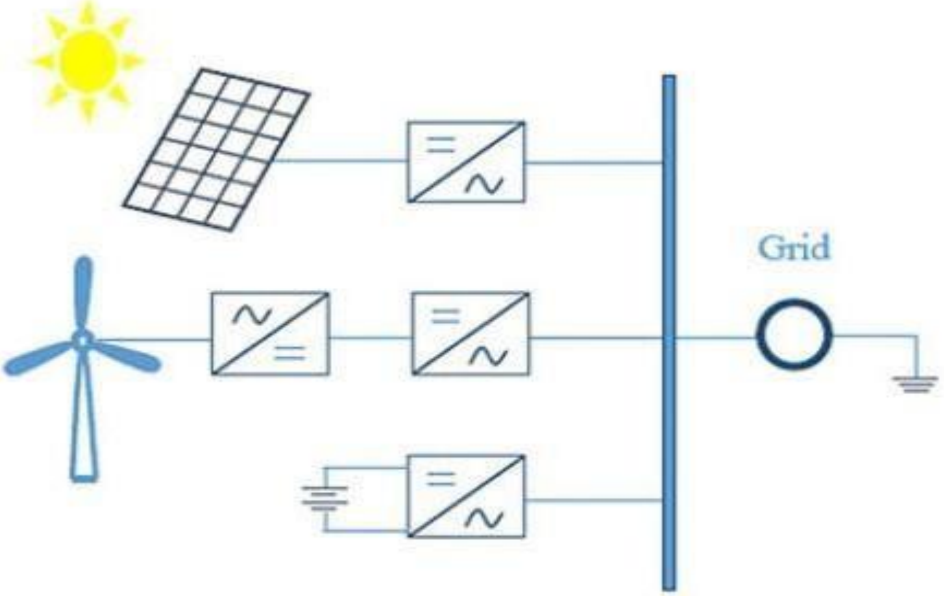


Fig 1.3 Grid connected hybrid system at common AC bus

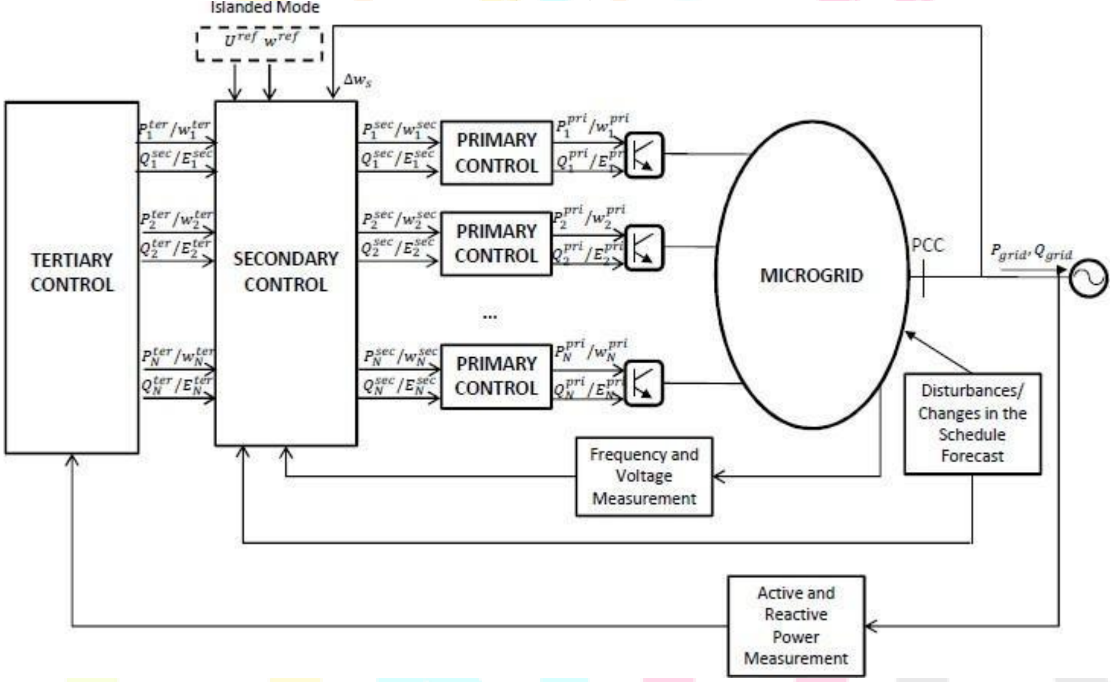


Fig 1.4 Microgrid control level architecture

## LITERATURE SURVEY

The micro grid is a platform for integrating a variety of Distributed Energy Resources (DERs), such as photovoltaic cells, wind power, fuel cells, micro turbines, and Distributed Storage (DS) units and loads. In micro grids systems, DERs operate as a local grid that can be connected to or disconnected from the main grid at the point of common coupling (PCC)To achieve improved operating efficiency, enhanced stability, and lower emission levels through sustainable micro-sources, a micro grid must be developed with a larger power capacity and more control capabilities It can function in one of two modes: utility-grid connected or autonomous (islanded).In the utility-grid-connected mode, power 16 is either supplied by the grid or injected into the grid by the micro grid connected to the grid.Micro grids function autonomously in islanding mode, separating from the utility grid and supplying loads via batteries.

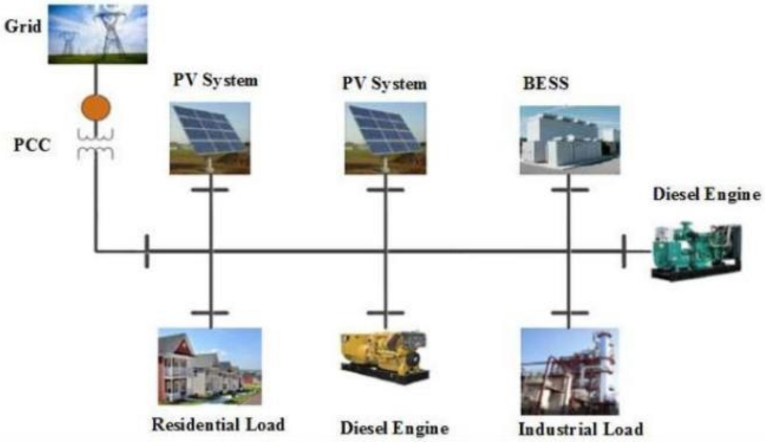


Fig 2.1 Hybrid grid

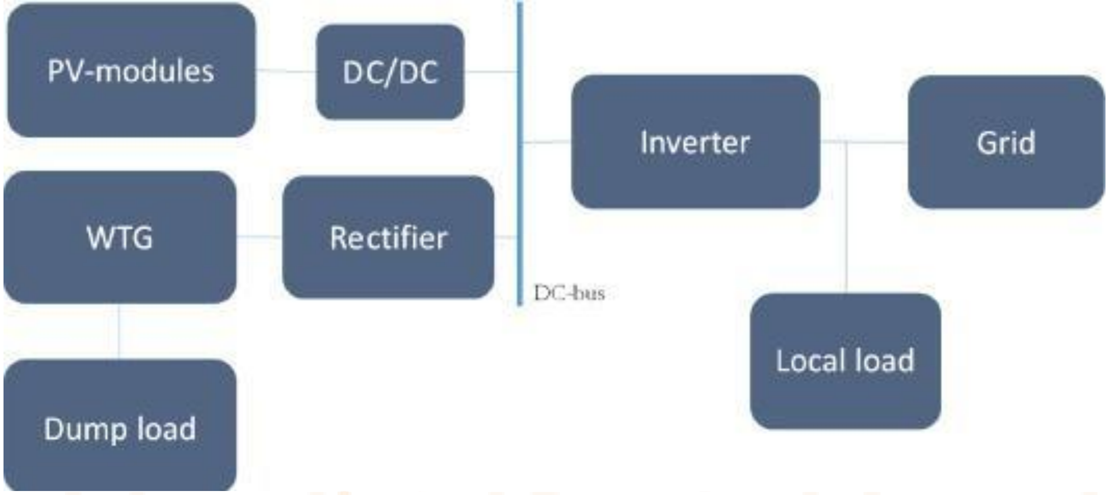


Fig 2.2 Grid connected to dc bus

## METHODOLOGY

Diesel generators are most commonly used as a stand-alone power supply system application to remote and isolated communities for their reliability, cheap installation and ease of starting. Hybrid combinations of two or more energy sources along with energy storage can improve reliability and ensure a continuous and cost-effective power supply

## DC COUPLED SYSTEMS

In a dc-coupled system, all renewable energy sources areconnected to a dc bus. System is flexible and can be connected to an ac load of 50/60 Hz frequency. Synchronisation of output voltage and power sharing are required to achieve desired load distribution

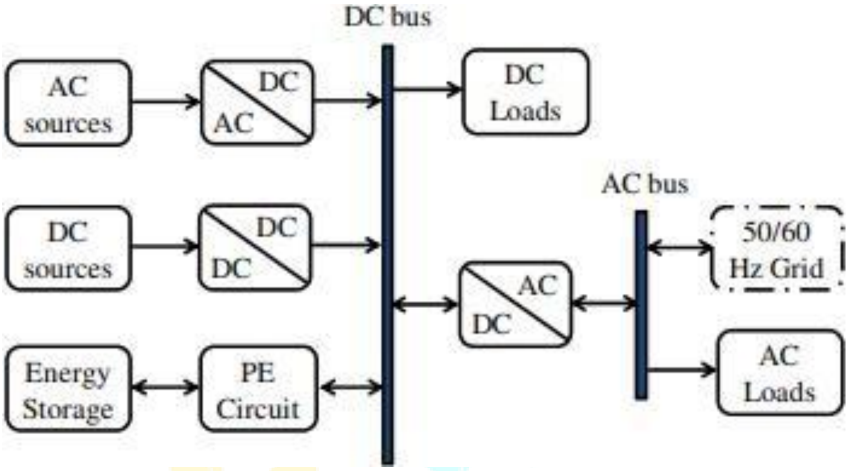


Fig 3.1 Dc coupled System

## AC COUPLED SYSTSEMS

Ac-coupled systems can be divided into two categories: power frequency accoupled (PFAC) and high frequency ac-ac coupled (HFAC). The different energy sources are integrated through their own power electronic interfacing circuits. In both PFAC and HFAC systems, dc power can be obtained through an ac-dc converter

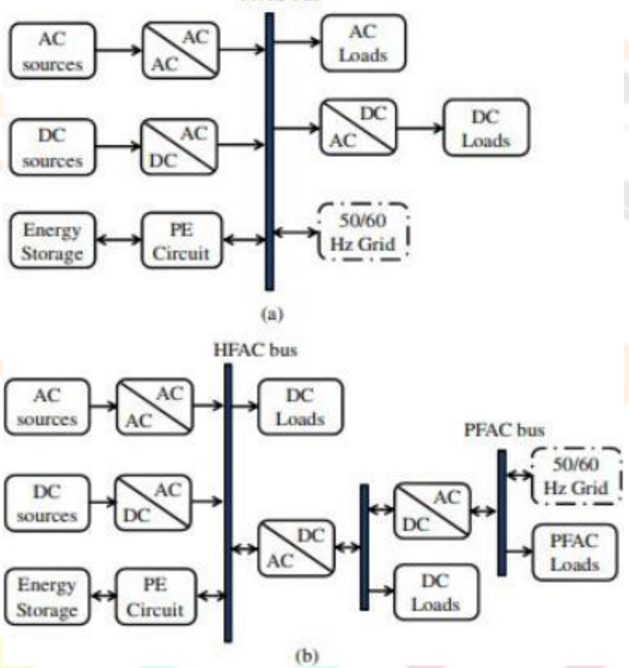
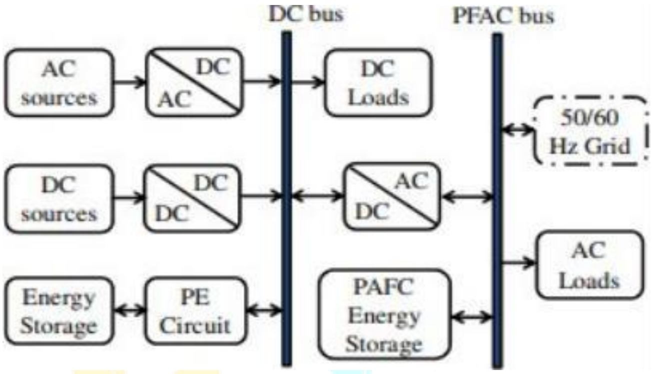


Fig 3.2 AC coupled system

## HYBRID COUPLED SYSTEMS

Various DG sources are connected to the hybrid system's dc or ac buses in a hybrid-coupled system.Some energy sources can be implemented directly in this application without the usage of a power electronic interfacing system.As a result, the system can run more efficiently and at a lower cost.Control and energy management, on the other hand, can be more difficult than with dc-coupled and ac-coupled systems. The various coupling systems each have their own set of uses.A dc-coupling system is preferable if the principal generation sources provide dc power and the system has a significant dc load.If the major power systems are ac and there are significant ac loads, an ac-coupled system is preferred.The hybrid coupled system is the optimum if the principal power generation system is a combination of ac and dc power



## STUDIED IHPS MODEL

The studied IHPS model includes a DEG, WTG, and STPG. Fig (1) shows the schematic of the designed IHPS model. The chosen parametric values of the studied IHPS and GHPS model are depicted in Table 1. As an energy storage device, a SMES block is added. A 150 kW WTG and a 150 kW DEG is the system model considered [4]. The cumulative power balance equation of the designed IHPS model is given by (1)

$$\Delta IH = \Delta G + \Delta G + \Delta G - \Delta L - \Delta E \qquad (1)$$

Where,

ΔIPHS - Total output deviation of IHPS model
ΔGD - Output power deviation of the DEG.

ΔSTPG - Output power deviation of the STPG.

ΔGW - Output power deviation of the WTG.
ΔL - Change in load demand.

ΔSMES - Output power deviation of the SMES.

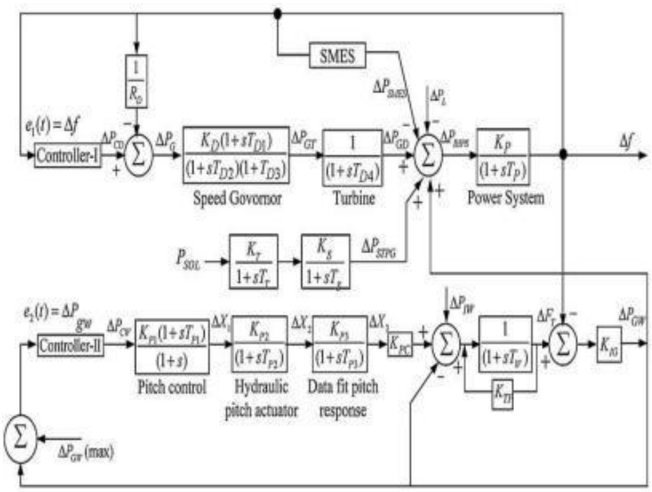


Fig IHPS model Block diagram

## STUDIED GHPS MODEL

The designed GHPS model is composed of a WTG and a STPS. The cumulative power balance equation of the designed GHPS model is given by

$$\Delta GH = \Delta G + \Delta - \Delta L \cdots (2)$$

Where,

ΔGPHS model. - Total output deviation of GHPS

ΔGW - Output power deviation of the WTG.

ΔM - Output power deviation of the steam turbine.

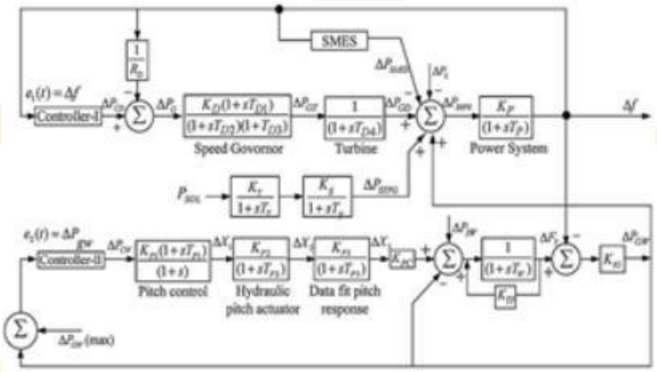


Fig 3.5 GHPS model Block diagram

## MULTIGRID TECHNOLOGY

\The direct-drive operation of generators may need electrical machinery of significant size, weight, and cost as the WECS rated power increases. In this scenario, a topology developed by the German firm multigrid is demonstrated. A WECS with a medium-speed PMSG and a single-stage gearbox with a gear ratio of 6–10 [90], [91] was created using the multigrid concept. This provides for weight and size reductions in the generators, as well as lighter, more dependable, and less expensive gearbox technology than the usual three-stage gearbox with a typical ratio of 80–100.

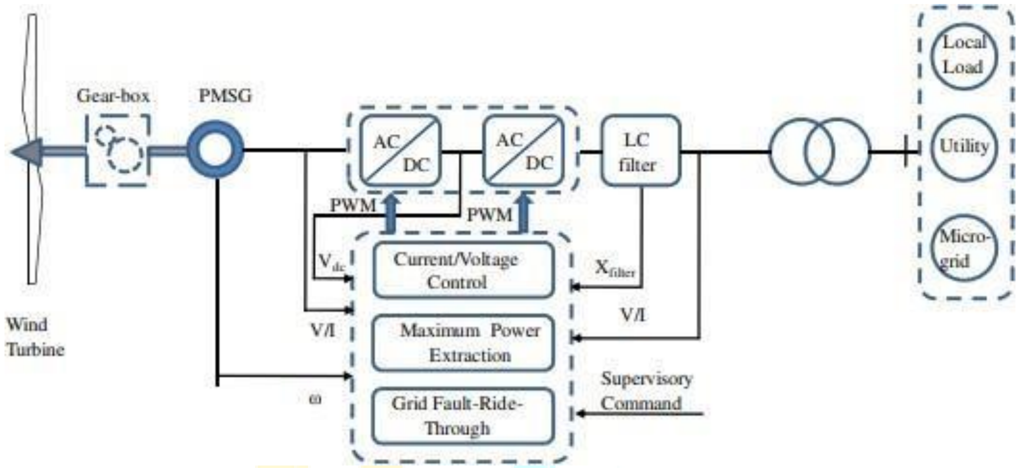


Fig Multigrid Technology

## OBSERVATIONS AND GRAPHS

Basics and definitions of solar radiation

Many physical, chemical, and biological processes on the earth's surface are driven by solar radiation, and complete and accurate solar radiation data for a specific region are critical for research and application fields such as architecture, industry, agriculture, environment, hydrology, agrology, meteorology, limnology, oceanography, and ecology.

Solar radiation data is also an important input for solar energy applications such photovoltaic systems for electricity generation, solar collectors for heating, solar air conditioning climate management in buildings, and passive solar devices.

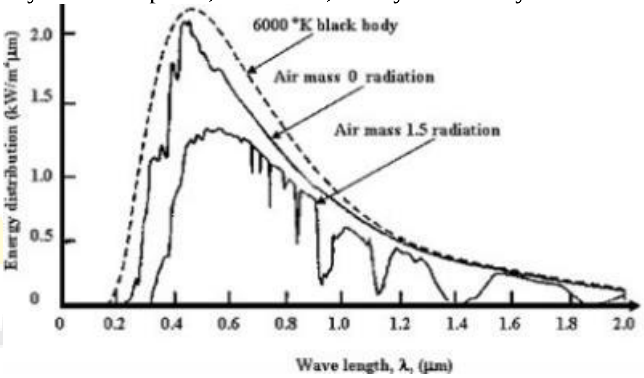
For the purposes of this report, data from NREL, NASA, IMD, and other sources was compared.

All of these sources include information on global irradiance, which is calculated using data collected over one-hour intervals and averaged over a month. The information is accessible for horizontal surfaces, but it will need to be converted for use with slanted solar collectors.

H is for monthly average daily solar radiation on a horizontal surface, and I stands for hourly total radiation on a horizontal surface.

In the diagram below, the solar spectrum, or the range of wavelengths received from the Sun, is displayed.

At typical temperatures, short wave radiation (0.3 to 3 m) is received from the Sun, and long wave radiation (greater than 3 m) is emitted by the atmosphere, collectors, or any other body.



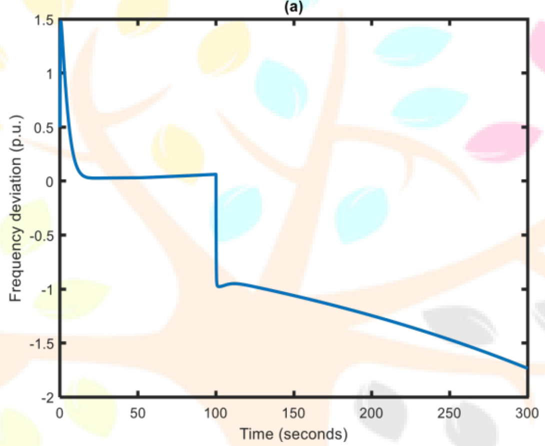
## RESULT AND ANALYSIS

Under varied operating conditions, different combinations of energy resources and storage units for the researched IHPS and GHPS models are investigated. To do the time-domain analysis, the models are simulated in

MATLAB Simulink for various types of load disturbances. The existence of unpredictably renewable energy producing components such as wind and solar power units causes a continual change in grid frequency throughout the system. As a result, it's crucial to keep the power quality within reasonable bounds. To solve this problem, a controller is added to the loop. The energy storage systems get a signal from the controller to consume/deliver a surplus/shortage of electricity from/into the grid. It instructs the generating unit to provide a huge burst of power into the grid to meet the short-term load demands.

*Case 1:IHPS with DEG,WTG and SPTG*

This model uses a base wind power of 0.01 p.u. and a solar power system with a base power of 0.2 p.u. Under full load conditions, the system's time domain response is evaluated. Figure 5 depicts the examined model's simulation results, whereas Figures 5(a) and 5(b) depict the frequency deviation profile of the developed model without and with SMES, respectively. At t=100s, the time-domain analysis is completed, and an SLP of 1% is applied. When SMES is not applied to the system, the system is unable to reach the steady-state condition, however when SMES is applied to the system, the scheduled frequency is reached in less than 6.6 seconds.



Graph

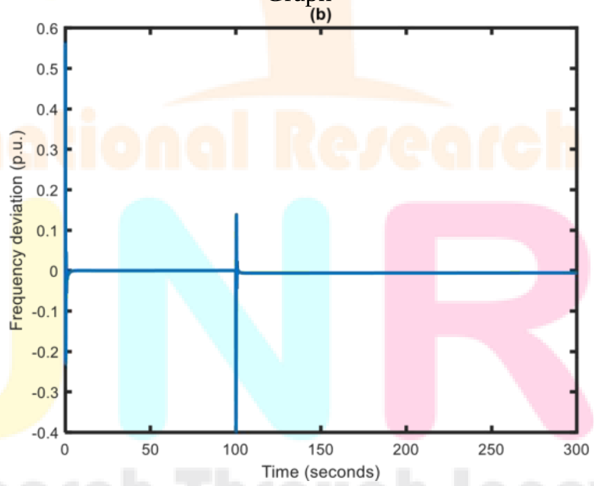
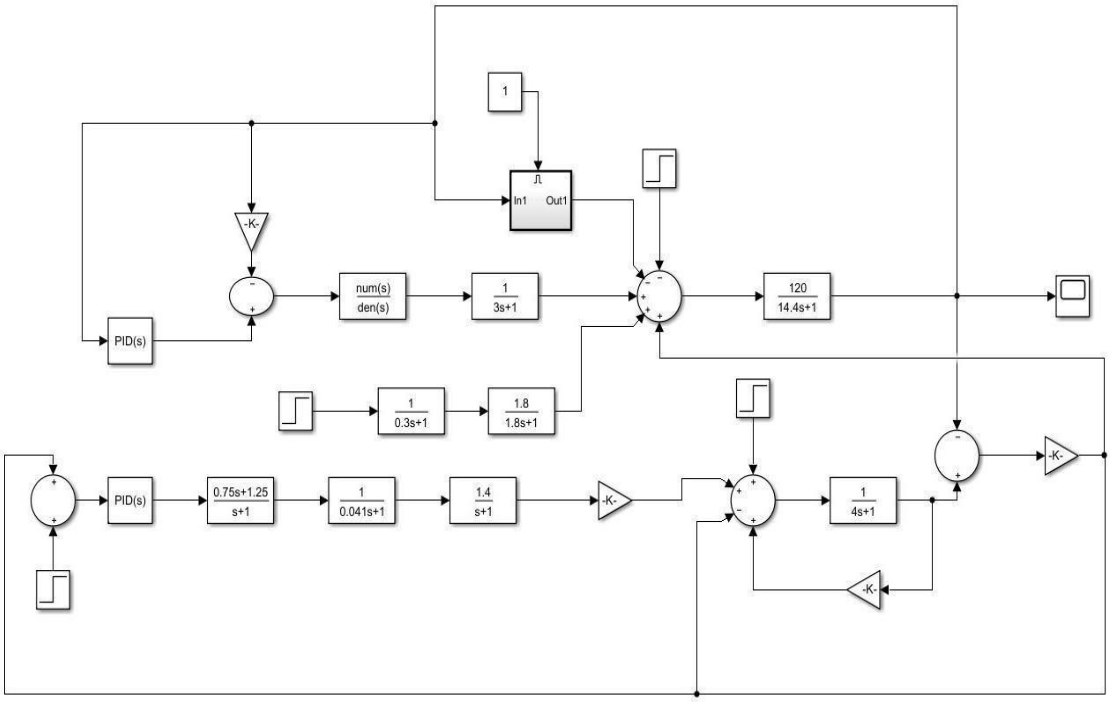
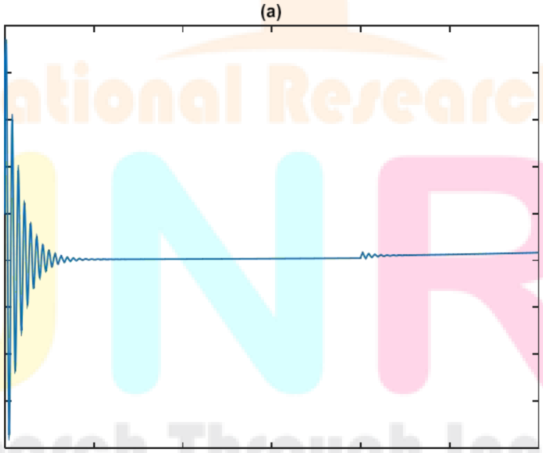


Fig 4.1: Dynamic response of Case 1 with 0.01 p.u. SLP (a) Δwithout SMES (b) Δ with SMES



*Case 2:GHPS with WTG and STPS:*

At t=100s, an SLP of one percent is applied to the time-domain analysis. The simulation results of the examined model are shown in Figure 6. A time-domain comparison is made between a system comprising only STPS and a system containing both WTG and STPS. In comparison to the system using only STPS, the dynamic response of this system using WTG and STPS shows that f is driven back to zero with less oscillations. The settling time for frequency variation using WTG and STPS is minimised.



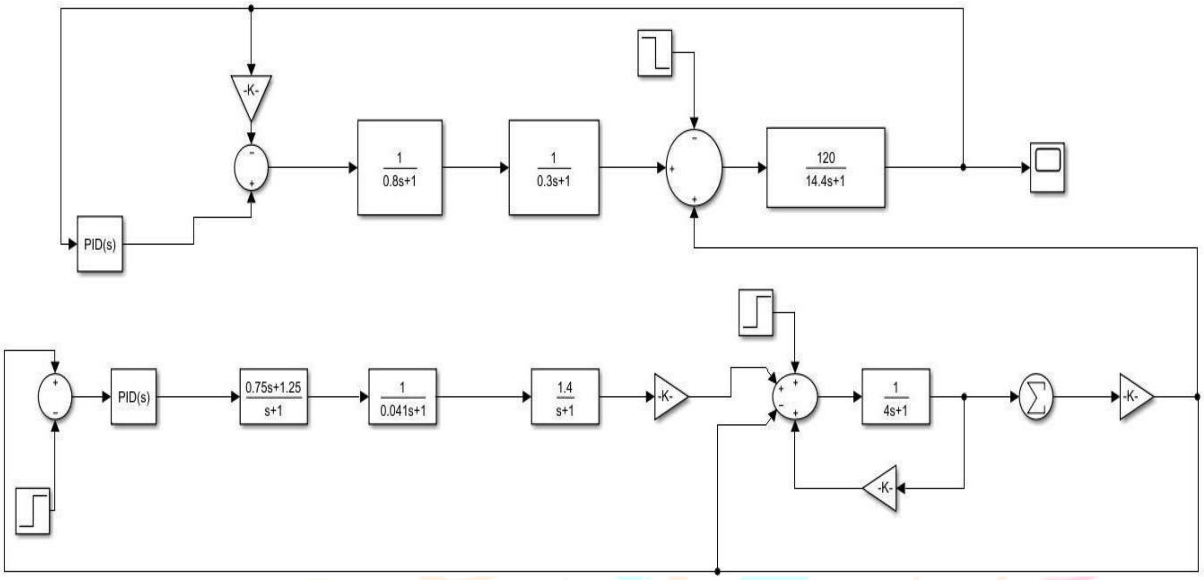


Fig Dynamic response of Case 2 with 0.01 p.u. load disturbance (a) with only STPS (b) with WTG and STPS

## CONCLUSION

This research looked on the load frequency stability of the microgrid with the integration of RESs.With numerous uncertainties, the investigation is carried out for the IHPS and GHPS models.A SMES unit is linked to the investigated IHPS model to improve system stability and reduce power oscillations.Following a step load perturbation, the system is restored back to normal operating conditions using the planned PI controller and SMES.When looking at the simulation results, it's clear that the system with SMES linked has accomplished load frequency stabilization

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