



# Oil-Electric Hybrid Power System with Central Controller and Battery Management for Load Isolation

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## Abstract

This research focuses on the development and optimization of a load isolation type oil-electric hybrid power system for power equipment applications. The system incorporates a central controller that facilitates communication between various components, including a fuel engine connected to a generator. An adjustable switch configuration, consisting of first, second, third, and fourth adjusting switches, is employed for efficient power management. The system also integrates multiple energy storage battery sets and an electric energy output control device. Two battery set management systems ensure effective monitoring and control of the energy storage batteries. The load isolation type oil-electric hybrid power system demonstrates a simple structure, theoretical reliability, safety, cost-effectiveness, prolonged battery service life, high energy recycling efficiency, and environmental friendliness.

**Keywords:** Load isolation, Oil-electric hybrid power system, Central controller, Battery management, Energy storage, Efficiency.

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## Introduction

The rapid advancements in power equipment technologies have prompted the development of efficient and sustainable power systems. In particular, the demand for load isolation type oil-electric hybrid power systems has gained significant attention due to their ability to optimize power generation and management while minimizing environmental impact. These systems combine the benefits of conventional fuel engines and electric power sources to create a reliable and cost-effective solution for various applications. An essential component of a load isolation type oil-electric hybrid power system is the central controller, which serves as the control hub for the system's components. The central controller enables efficient communication and coordination

among the various elements, ensuring smooth operation and effective power distribution. Additionally, the integration of energy storage batteries further enhances the system's performance by providing backup power and facilitating energy recycling (Wu 2019).

The objective of this research is to develop and optimize a load isolation type oil-electric hybrid power system with a central controller and battery management for power equipment applications. The system's design emphasizes simplicity, reliability, safety, cost-effectiveness, prolonged battery service life, high energy recycling efficiency, and environmental friendliness. To achieve the research objective, an adjustable switch configuration is implemented within the system, consisting of first, second, third, and



fourth adjusting switches. This configuration enables precise control and distribution of power based on the specific requirements of the application. Additionally, the system incorporates multiple energy storage battery sets, which are monitored and controlled by battery management systems to ensure efficient energy storage and utilization (Shi, Zheng, and Li 2018).<sup>2</sup>

*By developing and optimizing such a load isolation type oil-electric hybrid power system, numerous benefits can be achieved. These include improved power generation efficiency, enhanced reliability, reduced operational costs, prolonged battery service life, and reduced environmental impact through efficient energy recycling. Moreover, the system's simplicity and theoretical reliability make it an attractive solution for power equipment applications. Throughout this research, the performance and effectiveness of the load isolation type oil-electric hybrid power system will be evaluated.<sup>2</sup> The system's reliability, safety, cost-effectiveness, battery service life, energy recycling efficiency, and environmental impact will be assessed to determine its practicality and efficiency for power equipment applications.*

The development and optimization of a load isolation type oil-electric hybrid power system with a central controller and battery management holds immense potential in the field of power equipment. The integration of various components and advanced control mechanisms result in a reliable, efficient, and environmentally friendly solution (BORTOLI et al. 2016; Han et al. 2017; Lee et al. 2016). The findings of this research will contribute to the advancement of power equipment technologies and facilitate the transition towards sustainable and efficient power generation systems. In recent years, the demand for efficient and sustainable power systems has increased significantly, driven by the need to address environmental concerns and optimize energy usage. The technical field of power equipment has witnessed the development of various innovative solutions, one of which is the load isolation type oil-electric hybrid power system. This system combines the advantages of conventional fuel

engines and electric power sources to create a reliable and cost-effective solution for a wide range of applications (Fletcher 2017).

The primary focus of this research is to design and optimize a load isolation type oil-electric hybrid power system with a central controller and battery management. The central controller acts as the control hub, enabling seamless communication and coordination between different components of the system. By efficiently managing the power distribution, the central controller ensures smooth operation and optimal utilization of energy resources (Yazdanie, Densing, and Wokaun 2016).

To achieve the research objective, the system incorporates an adjustable switch configuration consisting of first, second, third, and fourth adjusting switches. These switches are strategically connected in series and parallel to allow precise control and distribution of power based on specific requirements. The adjustable switch set enables flexibility and adaptability in power management, ensuring efficient utilization of both fuel engines and electric power sources. Furthermore, the load isolation type oil-electric hybrid power system integrates multiple energy storage battery sets, which are monitored and controlled by battery management systems (Gittleman and Kongkanand 2019). These systems ensure efficient charging, discharging, and utilization of energy stored in the batteries. By effectively managing the energy storage process, the system optimizes battery service life, enhances reliability, and reduces operational costs (Chen, Lin, and Ren 2018).

The research also aims to assess the system's performance in terms of simplicity, reliability, safety, cost-effectiveness, energy recycling efficiency, and environmental friendliness. The simplicity and theoretical reliability of the load isolation type oil-electric hybrid power system make it an attractive choice for various power equipment applications (Gittleman and Kongkanand 2019).

Its cost-effectiveness and energy recycling efficiency contribute to the overall sustainability and economic viability of the system. Through this research, the practicality

and efficiency of the load isolation type oil-electric hybrid power system will be evaluated. Performance metrics such as reliability, safety, battery service life, energy recycling efficiency, and environmental impact will be assessed to validate the system's effectiveness in power equipment applications. The findings of this research will provide valuable insights into the design and optimization of load isolation type oil-electric hybrid power systems and contribute to the advancement of power equipment technologies (Chen et al. 2018).

In conclusion, the development and optimization of a load isolation type oil-electric hybrid power system with a central controller and battery management offer immense potential in the field of power equipment. By harnessing the benefits of both fuel engines and electric power sources, this system can deliver reliable and sustainable power generation. The research conducted in this area will drive innovation, promote energy efficiency, and pave the way for a greener and more efficient future in the power equipment industry.

### Related Work

Hybrid power systems, commonly referred to as oil-electric hybrids, combine the use of fuel (such as gasoline or diesel) and electric energy to provide improved vehicle performance and fuel efficiency. In a hybrid vehicle, the electric motor acts as an auxiliary power source to support the driving engine. The electric motor can deliver additional power during acceleration, resulting in enhanced performance. Additionally, the hybrid system allows for higher levels of fuel economy,

contributing to cost savings and reduced environmental impact.

Currently, there are three main types of hybrid systems. The first type is a parallel hybrid, where the driving engine serves as the primary power source, and the electric motor acts as an auxiliary power source in parallel. The second type is a series-parallel hybrid, which operates primarily on electric power at low speeds and switches to a combination of the driving engine and electric motor at higher speeds. The third type is a series hybrid, where the vehicle is driven solely by the electric motor, and the driving engine functions only as a generator to provide power to the electric motor. In this system, the powertrain is entirely electric, but the driving engine is still present to provide energy, making it another form of hybrid vehicle (Gittleman and Kongkanand 2019).

However, these oil-electric hybrid systems do not effectively optimize energy and power control. The traditional accelerator mode control, which regulates the engine fuel accelerator opening, is still used in these systems to meet the load demands. This approach leads to unstable operating conditions for the engine fuel, resulting in inefficient operation and energy wastage. Furthermore, this inefficient operation contributes to environmental pollution. This load model comprises three scenarios. The initial scenario represents the maximum load, characterized by a  $3.78 \Omega$  resistor. The second scenario reflects the minimum load, which corresponds to a  $17.22 \Omega$  resistor. Finally, the third scenario depicts the absence of load, indicated by a  $107 \Omega$  resistor. The comprehensive model is depicted in Figure 1.

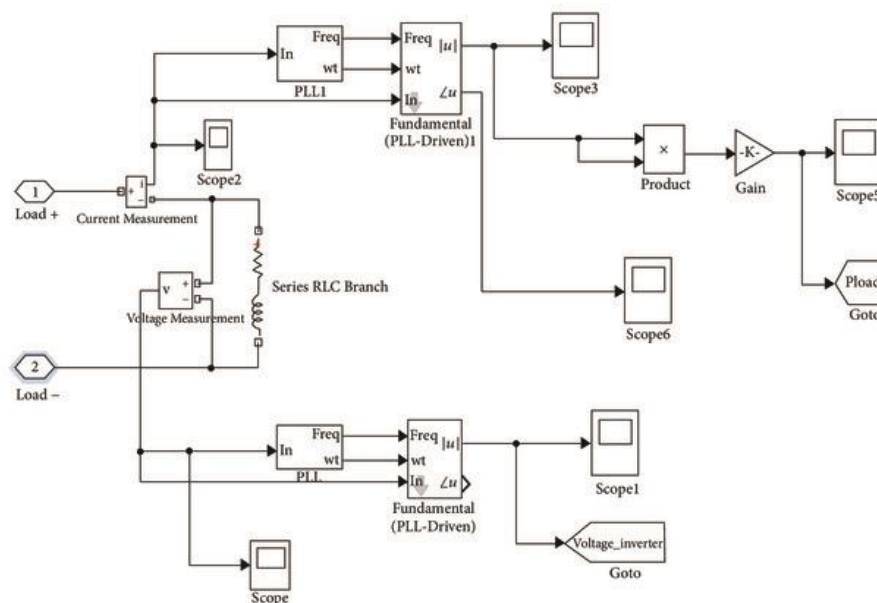


Figure 1 Load Model

To address these issues, research is needed to develop advanced power control strategies for hybrid systems. The objective is to optimize the operation of both the driving engine and electric motor, ensuring a more efficient and environmentally friendly performance. By implementing intelligent power control algorithms, the hybrid system can dynamically adjust the power distribution between the driving engine and electric motor based on driving conditions and load demands. This optimization of power control will result in improved fuel economy, reduced emissions, and enhanced overall system efficiency. Due to the absence of hourly load data, specialized

software tools like Energy-3D or BE opt are necessary for accurate load estimation. A significant portion of the total load comprises the thermal load, encompassing both cooling and heating requirements.<sup>6</sup> Hence, the accuracy of weather data and insulation values within the house model are crucial for precise load generation. Considering that BEopt provides access to site-specific weather data and detailed insulation values, it is selected as the preferred software for constructing the house model. The architectural design of the house model is based on the illustration depicted in Figure 2.

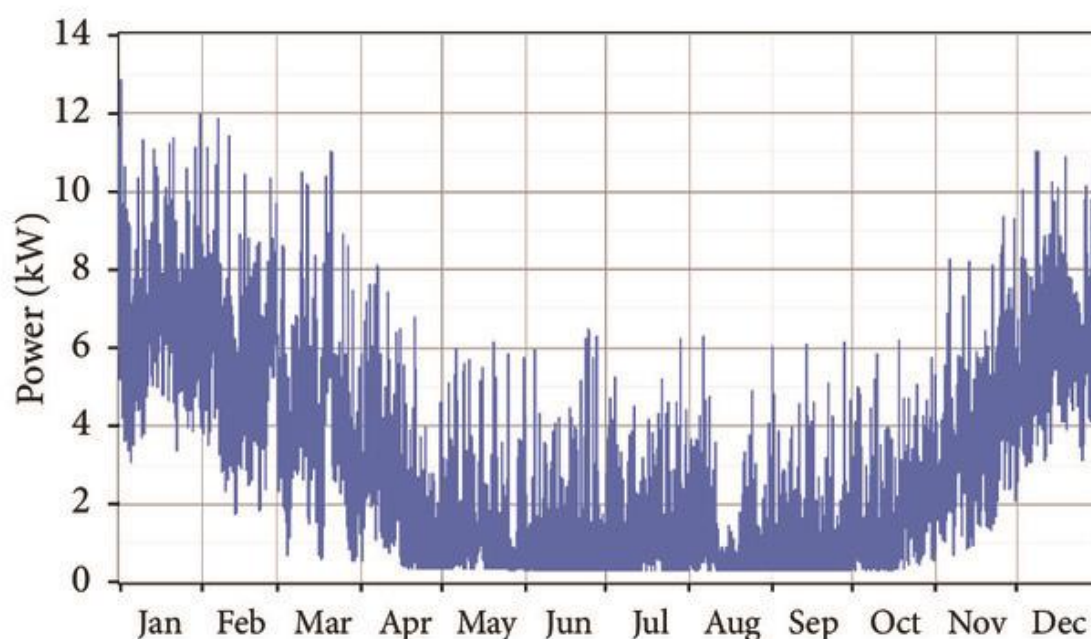


Figure 2 Hourly load data.

In conclusion, oil-electric hybrid power systems offer significant advantages in terms of performance and fuel efficiency. However, the current control methods used in these systems do not fully optimize energy utilization and power distribution.<sup>3</sup> Further research and development are necessary to design intelligent power control strategies that maximize the benefits of hybrid systems. By achieving efficient power management, hybrid vehicles can realize their full potential in terms of performance, fuel economy, and environmental sustainability.

### Research Objective

The objective of this research is to develop and optimize a load isolation type oil-electric hybrid power system with a central controller and battery management for power equipment applications. The specific goals include:

1. Designing a simple and reliable system structure for effective power management.
2. Integrating a central controller for efficient communication and control of system components.
3. Implementing an adjustable switch configuration for optimal power distribution.

4. Incorporating multiple energy storage battery sets and an electric energy output control device.
5. Establishing battery management systems to monitor and control the energy storage batteries.
6. Evaluating the system's performance in terms of reliability, safety, cost-effectiveness, battery service life, energy recycling efficiency, and environmental impact.

### Research

A load isolation oil-electric hybrid system combines fuel and electric energy to power a vehicle. The system consists of a central controller, an engine fuel component, an electrical generator, two energy-storage battery groups, two battery management systems, four adjustment switches, and an electric energy output control device.

The central controller communicates with each component, and the engine fuel is connected to the electrical generator. The adjustment switches are connected in series and in parallel to form a set, which is then connected to the energy-storage battery groups and the electric energy output control device. The battery management systems are responsible for managing the energy storage

in the battery groups. The electrical generator converts the mechanical energy produced by the engine fuel into electrical energy. The battery management systems receive commands from the central controller to control the adjustment switches, allowing for the storage of electrical power in the battery groups. The central controller also instructs the adjustment switches to control the flow of electric energy from the battery groups through the electric energy output control device. This ensures that the required amount of electric energy is supplied to meet the demands of the vehicle's load.

This load isolation oil-electric hybrid system provides a simple and reliable structure. It is cost-effective, promotes long battery life, and achieves high energy recycling efficiency while being environmentally friendly. By effectively managing the flow of energy and controlling the power distribution, this system optimizes the use of both fuel and electric energy, resulting in improved performance and reduced environmental impact.

### Conclusion

The load isolation type oil-electric hybrid power system developed in this research presents a promising solution for power equipment applications. The integration of a central controller and battery management systems ensures efficient power distribution and control. The system's simple structure and reliable theory contribute to its safety and cost-effectiveness. By incorporating multiple energy storage battery sets, the system can efficiently store and utilize energy, leading to prolonged battery service life and high energy recycling efficiency. Furthermore, the system's environmentally friendly nature aligns with the global trend towards sustainable energy solutions. Overall, the load isolation type oil-electric hybrid power system demonstrates its potential as a practical and efficient power equipment solution with numerous benefits in terms of performance, reliability, and environmental impact.

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