

Comparison and Optimization of Energy's Source Consumption

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Abstract:

In the period of continually evolving electronic engineering, devices are becoming more intelligent and more multifunctional. However, this increased functionality enhances companies with higher energy consumption which places pressure on energy resources and poses sustainability challenges. Due to this point, this passage is going to discuss three different types of energy resources—batteries, power plants, and renewable energy—outlining their advantages and drawbacks while considering their shortcuts on environmental impacts. Batteries face limitations in capacity and disposal concerns. Power plants, especially those reliant on fossil fuels, offer reliability but contribute to emissions and resource limitation. Renewable energy, like solar and wind power, provides sustainable solutions but may be intermittent due to environmental effects. After that, this passage will determine the optimum choice under different circumstances to reach its maximum productivity.

Keywords: energy resource, battery, power grid, renewable energy

Introduction

In the domain of rapid digital advancement, technological devices have become more intelligent and multifunctional. These devices significantly appear in our daily lives, from airports to home automation systems, offering us more information and convenience. However, for these devices to integrate into our daily routines with greater proficiency, one of the most important concerns is to make them more efficient in terms of power consumption.

The development of these technologies not only focuses on more lightweight designs but also on minimizing power wastage while maintaining high performance. This article delves into the comparison of various types of energy consumption, explores their advantages and disadvantages, and examines how to optimize energy management in different contexts.

1. Battery

First and foremost, batteries are considered the primary energy source for mobile devices and portable electronic products. Batteries store electrical energy, meaning they do not directly generate energy. They are used for storing and releasing energy, providing electrical power when needed. The biggest advantage of using batteries is their lightweight and portability, allowing devices to be used without being tethered to power outlets. This crucial feature makes batteries suitable for mobile devices such as smartphones, laptops, and tablets.

However, the composition of batteries raises environmental concerns. Some of the chemical components in batter-

ies can cause contamination if not disposed of properly. Two main types of batteries on the market are Lithium-Ion batteries and Nickel-Cadmium batteries. According to the report by Battery Company “Waaree es,” their Lithium-Ion batteries have a positive electrode made of lithium cobalt oxide (LiCoO₂) and a negative electrode made of carbon (Waaree es). Lithium-Ion batteries are more environmentally friendly and easier to recycle compared to Nickel-Cadmium batteries.

Nickel-Cadmium batteries pose significant health threats. Cadmium, a heavy metal, is toxic and can have severe biochemical effects on the body, including the respiratory and digestive systems (Utmel, 2021). Due to these concerns, Lithium-Ion batteries are seen as having greater potential for future use because of their lower environmental impact, easier recyclability, and less toxicity.

In addition, the development of new batteries has led to some attempts at using solid-state. They are able to use solid electrolytes instead of liquids, providing higher energy densities and safety. Solid-state batteries could update the energy storage by providing more efficient and durable power. Based on this solution, car company Toyota is researching solid-state batteries and has projected commercial availability by the 2020s. These batteries are expected to offer higher capacity and faster charging times, addressing some of the current limitations of lithium-ion technology.

2. Electric Grid Power

Another main electronic resource is electric grid power, often generated by power plants and transmitted to homes

through cables, usually underground. The biggest advantage of electric grid power is its reliability, as power plants continuously supply electricity. This makes electric grid power suitable for devices that require continuous power, like refrigerators or street lamps. Unlike batteries, the electric grid transmits power continuously rather than storing it.

However, the environmental impact of electric grid power is significant. The reliance on fossil fuels for electricity generation contributes to greenhouse gas emissions and environmental degradation. According to the American Geosciences Institute, the expansion of electric grids can lead to overexploitation of land, loss of biodiversity, and pollution (WowEssays, 2020). In 2019, only 36.7% of global electricity came from low-carbon sources, with the remaining two-thirds generated from fossil fuels like coal and gas (Hannah Ritchie & Max Roser, 2022). The burning of fossil fuels releases carbon dioxide, a major greenhouse gas, contributing to global climate change (Edubirdie, 2022).

Additionally, the infrastructure required for electric grids can have significant environmental impacts. The construction of power plants, transmission lines, and substations can disrupt natural habitats and landscapes. This is particularly concerning in ecologically sensitive areas where biodiversity may be at risk.

Nowadays, researchers are working to switch to power grids that are better for the environment. With the integration of renewable energy sources like wind, solar, and hydropower into the grid. Smart grid technologies are also being developed to enhance the efficiency and reliability of electricity distribution. These technologies use advanced communication to better manage electricity demand, reduce waste, and integrate renewable energy sources more effectively.

For example, countries like Germany are leading the way in smart grid implementation with their “Energiewende” (energy transition) initiative. This idea aims to increase the use of more renewable energy, use energy better, and make less greenhouse gases. As a driver of modernisation and innovation for industry, it can create growth and sustainable and secure jobs. Precisely that is what counts if we want to win over international partners for this unique project for the future. (Ebert, 2024)

3. Renewable Energy

Renewable energy sources, such as solar and wind power, offer a sustainable alternative. Family-use generators powered by renewable energy are not continuous or stable, as they depend on environmental conditions. Despite this intermittency, renewable energy is a promising substitute

when conventional power runs out. The sustainability of solar and wind energy makes them attractive options for reducing reliance on fossil fuels.

Renewable energy also presents challenges. Weather variability can affect the consistency of power generation. For instance, solar power depends on sunlight, which can be inconsistent due to weather conditions or geographic location. Wind power relies on wind speed, which can also be unpredictable. These factors make it necessary to have backup power sources or energy storage solutions to ensure a stable power supply.

However, renewable energy’s environmental benefits are substantial. Unlike fossil fuels, renewable energy does not produce greenhouse gasses or toxic byproducts. The shift to renewable energy is crucial to mitigate climate change and reduce environmental degradation (GradesFixer, 2019). Additionally, advancements in energy storage technologies, such as batteries and pumped hydro storage, are helping to address the intermittency issue by storing excess energy generated during peak production times for use during periods of low generation.

Solar power, one of the most popular forms of renewable energy, has seen significant advancements. Photovoltaic (PV) cells, which convert sunlight directly into electricity, have become more efficient and cost-effective. Innovations in PV technology, such as the development of perovskite solar cells, promise even higher efficiencies and lower costs in the future.

Wind power has also developed technologically with larger and more efficient wind turbines. Wind farms in the ocean, called offshore wind farms, are getting more prominent. They use strong, steady winds to generate electricity.

Moreover, government policies and international agreements play roles in promoting renewable energy. For example, the Paris Agreement aims to limit global warming to well below 2 degrees Celsius above pre-industrial levels, with efforts to limit the temperature increase to 1.5 degrees Celsius. Reaching these goals means using a lot more renewable energy and abandoning the use of fossil fuels. Countries worldwide are establishing ambitious goals for renewable energy and putting in place policies to help develop and use renewable energy technologies.

Future Trends and Innovations

The energy sector is constantly evolving with advancements aimed at improving efficiency and sustainability. In the realm of batteries, research is focused on developing new materials and technologies to enhance energy density, reduce costs, and improve recyclability. For instance, solid-state batteries are being explored for their potential to offer higher energy densities and safety compared to traditional lithium-ion batteries.

Electric grids are also undergoing transformations with the integration of smart grid technologies. These technologies use digital communication to detect and react to local changes in usage, enhancing efficiency and reliability. Additionally, there is a push towards decentralizing energy generation with microgrids, which can operate independently of the central grid and integrate various renewable energy sources.

In the renewable energy sector, innovations in energy storage are crucial to address intermittency issues. Advances in battery storage, pumped hydroelectric storage, and new technologies like liquid air energy storage are being developed to store excess energy generated during peak production times for use during periods of low generation. Moreover, the development of hydrogen fuel cells presents another promising avenue for renewable energy. Hydrogen fuel cells produce electricity by combining hydrogen and oxygen, with water as the only byproduct. This technology has the potential to provide clean and efficient energy for a wide range of applications, from powering vehicles to providing backup power for the grid.

Economic Considerations

The economic implications of different energy sources are also critical to consider. The initial investment in renewable energy technologies can be high, but the long-term savings and benefits often outweigh these costs. For example, the cost of solar panels and wind turbines has decreased significantly over the past decade, making renewable energy more competitive with fossil fuels. Government incentives and subsidies also play a crucial role in promoting the adoption of renewable energy.

On the other hand, the cost of maintaining and upgrading the electric grid infrastructure can be substantial. Aging infrastructure in many countries requires significant investment to ensure reliability and efficiency. Transitioning to a more sustainable grid with integrated renewable energy sources and smart grid technologies will require substantial financial resources and policy support.

Furthermore, the economic benefits of renewable energy extend beyond cost savings. The renewable energy sector has the potential to create numerous jobs in manufacturing, installation, maintenance, and other related fields. Annual Review shows that jobs in the sector reached 11.5 million globally in 2019, up around 500 000 on 2018's 11 million jobs, led by solar PV with some 3.8 million jobs, or a third of the total. (Sherrard, 2020) This number

is expected to grow as the demand for renewable energy increases.

Environmental and Social Impacts

The environmental and social impacts of energy sources extend beyond greenhouse gas emissions and pollution. The extraction of materials for batteries, such as lithium and cobalt, can have significant environmental and social consequences. Mining activities can lead to habitat destruction, water pollution, and adverse effects on local communities. Ethical sourcing and recycling of battery materials are essential to mitigate these impacts.

Similarly, the construction of large-scale renewable energy projects, such as wind farms and solar installations, can affect local ecosystems and communities. Proper planning and environmental assessments are necessary to minimize these impacts and ensure that renewable energy projects are sustainable and socially responsible.

For instance, the development of large solar farms can lead to land use conflicts, especially in areas where land is scarce or used for agriculture. Balancing the need for renewable energy with land use priorities requires careful consideration and planning. Community engagement and involvement are crucial to ensure that the benefits of renewable energy projects are shared equitably and that potential negative impacts are addressed.

Conclusion

In conclusion, this paper has explored three kinds of energy sources—batteries, power grid, and renewable energy—and discussed their different features. From an environmental perspective, renewable energy resources are the best choice compared to batteries and the power grid. However, in terms of energy efficiency, the power grid is the most stable and continuous option for supporting large-scale energy demands. Batteries, while less damaging than fossil fuels, are ideal for portable devices due to their lightweight and wireless nature.

To sum up, batteries are optimal for portable devices such as flashlights, smartwatches, and smartphones. They are not suitable for high energy requirements, where power plants are more appropriate. Renewable energy, though affected by weather conditions, is environmentally friendly and sustainable. Future trends in energy technology aim to enhance the efficiency and sustainability of all three energy sources, ensuring a balanced approach to meeting our energy needs.

Variables	Battery (AA)	Electric Grid
Power Storage	1.5 V	Infinity
Toxicity	Yes	Yes
Environmental Friendly	Possibly	No

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