WIND-DIESEL HYBRID SYSTEM: ENERGY STORAGE SYSTEM SELECTION METHOD

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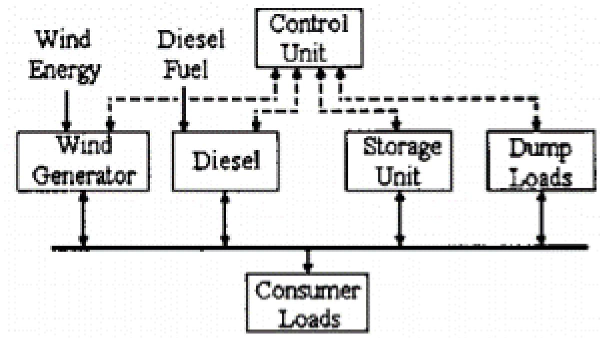
Abstract

Hybrid energy system is an outstanding solution for electrifying distant rural regions where it is hard and not economical to extend the grid. At very high financial and environmental expenses, electricity is generated in those distant locations using diesel generators. Since most of these places have excellent wind conditions, pairing a wind turbine with the diesel generator is an apparent solution to decrease this burden. However, the penetration factor must be held low in the lack of a storage system owing to the limitations associated with the diesel generator. This article discusses this method of optimization and the system idea chosen.

Key words: Hybrid energy system, diesel generators, wind turbine.

Introduction

A wind-diesel hybrid system is any independent electricity generating system that uses wind turbines[1], [2] with diesel generators to achieve maximum contribution from the intermittent wind resource to the complete electricity generated while delivering constant, high-quality electricity. With wind diesel systems with elevated wind penetration, these fuel consumption savings are maximum, in which the diesel generators can be shut down during high wind accessibility. Low-penetration systems[3] are those with instantaneous penetration peaks of less than 50 percent, and medium-penetration systems have at any moment between 50 percent -100 percent of their wind energy. However, high penetration devices (> 100% peak instantaneous penetration) still have many issues, particularly when equipped with this ability to operate in a diesel off mode. Figure 1 presents a generalized wind-diesel system schematic diagram.



Synthesis of the various energy storage techniques

Ragone's diagram[4] is usually used to depict efficiency in terms of the weight-to-energy and power ratio to compare storage systems.

1. Electrochemical batteries energy storage (BES)

   The batteries are prone to misuse and have several disadvantages that require further studies, particularly in order to enhance their life cycling (charging and discharge) and as they cannot be recycled, they cannot be used in the system.
2. Hydrogen energy storage (HES)

   Wind-energy hydrogen cannot be used as a fuel for diesel motors as they are not fitted with ignition systems.
3. Flywheel energy storage (FES)

   This type of storage, irrespective of the technology used, can be used to produce hot water for heating or for use in the community where the WDHS exists, using wind energy or excess heat from diesel exhaust gases.
4. Pumped hydraulic energy storage (PHS)

   It is a large-scale storage facility with centralized manufacturing.
5. Redox batteries Energy storage (RBES)

   Although the flow batteries can be used for small-scale apps such as large-scale apps, they are less mature and still require hybridization with wind energy to prove their operation.
6. Supercapacitors energy storage (SCES)

   This storage form is designed for small-scale apps and its medium-scale use needs a sequence of multi-element connections to obtain the necessary voltage.
7. Superconducting magnetic energy storage (SMES)

It is a very short-lived storage technology. The complexity of this scheme lies in the need for a cooling scheme, transformers and converters and a big infrastructure

Table 1. Elementary decision matrix for the criterion "adaptability to WDHS"

Adaptability to WDHS	PHS	CAES	FES	BES	RBES	HES	TES	SCES	SMES	Total
PHS		0	0	0	0.5	0	0	0	0	**0.5**
CAES	1		1	1	1	1	1	1	1	**8**
FES	1	0		0.5	1	0.5	0.5	0.5	0.5	**4.5**
BES	1	0	0.5		1	0.5	0.5	0.5	0.5	**4.5**
RBES	0.5	0	0	0		0.5	0	0.5	0.5	**2**
HES	1	0	0.5	0.5	0.5		0	0.5	0.5	**3.5**
TES	1	0	0.5	0.5	1	1		1	1	**6**
SCES	1	0	0.5	0.5	0.5	0.5	0		0.5	**3.5**
SMES	1	0	0.5	0.5	0.5	0.5	0	0.5		**3.5**

Conclusion

After analyzing various storage systems compatibility with WDHS, this technique showed that the CAES responds with a performance index of roughly 82% to the selection criteria. Other devices are also more or less efficient, but at price, simplicity, WDHS adaptability, the contribution to decreasing energy consumption and GHG emissions, and the lifespan of some difference. For these reasons, wind-related CAES technology has been embraced.

References

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