# FORM 2

**THE PATENTS ACT, 1970 (39 OF 1970)**

# AND

**THE PATENT RULES, 2003 COMPLETE SPECIFICATION**

# (See section 10 and rule 13) Title of Invention:

**“DESIGN AND ANALYSIS OF BATTERY SUPERCAPACITOR HYBRID ELECTRICAL ENERGY STORAGE SYSTEMS FOR REGULATION SERVICES”**

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The following specification describes the invention and the manner in which it is to be performed.

# FIELD OF INVENTION

The present invention relates to the field of designing & implementing a framework of supercapacitor for hybrid electrical vehicles or energy systems. The proposed invention also includes a framework of analysis for regulation services.

# BACKGROUND OF INVENTION

**[0001]** Background description includes information that may be useful in understanding the present invention. It is not an admission that any of the information provided herein is prior art or relevant to the presently claimed invention, or that any publication specifically or implicitly referenced is prior art.

**[0002]** A capacitor electric vehicle is a vehicle that uses supercapacitors to store electricity. Supercapacitors have a lower energy density than batteries, so most can’t support pure electric vehicles on their own. They also have a higher self-discharge rate than batteries, making them unsuitable for long-term storage.

**[0003]** A number of different types of supercapacitor systems that are known in the prior art. For example, the following patents are provided for their supportive teachings and are all incorporated by reference.

**[0004]** EP0858679A1:- A hybrid energy storage system (10) including a first energy storage device (12), such as a secondary or rechargeable battery, and a second energy storage device (14), such as an electrochemical capacitor. The electrochemical capacitor provides intermittent energy bursts to satisfy the

power requires of, for example, pulsed power communication devices. Such devices typically require power pulses in excess of those which conventional battery cells can easily provide for numerous cycles. The first and second energy storage devices may be coupled to output electronics to condition the output of the devices prior to delivering it to the application device.

**[0005]** Battery-Supercapacitor Hybrid Energy Storage System in Standalone DC Microgrids: A Review:- Global energy challenges have driven the adoption of renewable energy sources. Usually, an intelligent energy and battery management system is deployed to harness the renewable energy sources efficiently, whilst maintaining the reliability and robustness of the power system. In recent years, the battery-supercapacitor based hybrid energy storage system (HESS) has been proposed to mitigate the impact of dynamic power exchanges on battery's lifespan. This study reviews and discusses the technological advancements and developments of battery-supercapacitor based HESS in standalone micro-grid system. The system topology and the energy management and control strategies are compared. The study also discusses the technical complexity and economic sustainability of a standalone micro-grid system. A case study of a standalone photovoltaic-based micro-grid with HESS is presented.

**[0006]** Design and Management of Battery-Supercapacitor Hybrid Electrical Energy Storage Systems for Regulation Services:- Regulation services (RS) play an important role in maintaining the stability of electric grids by

correcting for short-term mismatches between electricity generation and demand. RS providers dynamically supply electricity to the grid or consume electricity from it, in response to regulation signals, in return for economic compensation. This capability is commonly realized through large-scale electrical energy storage (EES) systems based on batteries. However, the highly transient nature of the regulation signals implies that the batteries used for RS are subject to frequent charge and discharge cycles, leading to shortened battery life and thereby impacting the profitability of RS. In this work, we explore the use of hybrid EES (HEES) systems, which combine batteries and supercapacitors, to improve the profitability of RS. HEES systems have the potential to reduce the cost of providing RS by utilizing supercapacitors to respond to the high-frequency components of the regulation signal, prolonging battery life. However, realizing this potential presents several challenges. First, the benefits of HEES systems have a profound dependence on the type of hybrid topology (i.e., active or passive), which results in a trade-off between the implementation cost and the utilization of the supercapacitor capacity. Second, the allocation of energy storage capacity to batteries and supercapacitors should be carefully determined in the design phase because the reduction in battery replacement cost due to the use of supercapacitors must be balanced against the increased upfront cost for supercapacitors. Third, active HEES systems involve the problem of managing the power flows to batteries and supercapacitors so as to realize maximum cost benefits. To address these

challenges, we present a framework for the design and management of a HEES system, so as to maximize the profit from the perspective of an RS provider. This framework consists of i) a design-time capacity optimization phase that determines the best allocation of capacity to batteries and supercapacitors and

ii) a run-time management scheme that selects how the different storage devices are orchestrated considering their characteristics and the incoming regulation signal. Our experiments show that, with the proposed capacity optimization and management framework, the use of a passive or an active HEES system can improve the profit of RS providers by 1.16x or 5.44x, respectively.

**[0007]** Supercapacitors are superior to traditional capacitors due to their ability to store and release energy; however, they have not been able to replace the function of conventional lithium-ion batteries. The proposed invention focuses on analysing the importance of supercapacitors in increasing the efficiency of hybrid electrical vehicles. The algorithms of deep learning are used for the purpose of analysis of supercapacitor properties.

**[0008]** Above information is presented as background information only to assist with an understanding of the present disclosure. No determination has been made, no assertion is made, and as to whether any of the above might be applicable as prior art with regard to the present invention.

**[0009]** In the view of the foregoing disadvantages inherent in the known types of supercapacitor systems now present in the prior art, the present invention

provides an improved system. As such, the general purpose of the present invention, which will be described subsequently in greater detail, is to provide a new and improved system to predict the importance of supercapacitor in hybrid electrical charging systems that has all the advantages of the prior art and none of the disadvantages.

# SUMMARY OF INVENTION

**[0010]** In the view of the foregoing disadvantages inherent in the known types of supercapacitor systems now present in the prior art, the present invention provides an improved one. As such, the general purpose of the present invention, which will be described subsequently in greater detail, is to provide a new and improved system to predict the importance of hybrid electrical systems and supercapacitors which has all the advantages of the prior art and none of the disadvantages.

**[0011]** The main objective of the proposed invention is to design & implement a framework of systematic approach to analyse the efficiency of super capacitors. The invention aims at analysing the regulation services of hybrid electrical systems.

**[0012]** Yet another important aspect of the proposed invention is to design & implement a framework for analyzing the efficiency of supercapacitor by replacing the supercapacitor with different supercapacitor materials. The deep learning algorithm will analyse the impact of super capacitor and displays the results in the display unit.

**[0013]** In this respect, before explaining at least one embodiment of the invention in detail, it is to be understood that the invention is not limited in its application to the details of construction and to the arrangements of the components set forth in the following description or illustrated in the various ways. Also, it is to be understood that the phraseology and terminology employed herein are for the purpose of description and should not be regarded as limiting.

**[0014]** These together with other objects of the invention, along with the various features of novelty which characterize the invention, are pointed out with particularity in the disclosure. For a better understanding of the invention, its operating advantages and the specific objects attained by its uses, reference should be had to the accompanying drawings and descriptive matter in which there are illustrated preferred embodiments of the invention.

# BREIF DESCRIPTION OF DRAWINGS

**[0015]** The invention will be better understood and objects other than those set forth above will become apparent when consideration is given to the following detailed description thereof. Such description makes reference to the annexed drawings wherein:

Figure 1 illustrates the block diagram of design and analysis of battery supercapacitor hybrid electrical energy storage systems for regulation services, according to the embodiment herein.

# DETAILED DESCRIPTION OF INVENTION

**[0016]** In the following detailed description, reference is made to the accompanying drawings which form a part hereof, and in which is shown by way of illustration specific embodiments in which the invention may be practiced. These embodiments are described in sufficient detail to enable those skilled in the art to practice the invention, and it is to be understood that the embodiments may be combined, or that other embodiments may be utilized and that structural and logical changes may be made without departing from the spirit and scope of the present invention. The following detailed description is, therefore, not to be taken in a limiting sense, and the scope of the present invention is defined by the appended claims and their equivalents.

**[0017]** While the present invention is described herein by way of example using several embodiments and illustrative drawings, those skilled in the art will recognize that the invention is neither intended to be limited to the embodiments of drawing or drawings described, nor intended to represent the scale of the various components. Further, some components that may form a part of the invention may not be illustrated in certain figures, for ease of illustration, and such omissions do not limit the embodiments outlined in any way. It should be understood that the drawings and detailed description thereto are not intended to limit the invention to the particular form disclosed, but on the contrary, the invention covers all modification/s, equivalents and alternatives falling within the spirit and scope of the present invention as defined by the appended claims. The headings are used for organizational

purposes only and are not meant to limit the scope of the description or the claims. As used throughout this description, the word "may" be used in a permissive sense (i.e., meaning having the potential to), rather than the mandatory sense (i.e., meaning must). Further, the words "a" or "a" mean "at least one” and the word “plurality” means one or more, unless otherwise mentioned. Furthermore, the terminology and phraseology used herein is solely used for descriptive purposes and should not be construed as limiting in scope. Language such as "including," "comprising," "having," "containing," or "involving," and variations thereof, is intended to be broad and encompass the subject matter listed thereafter, equivalents, and any additional subject matter not recited, and is not intended to exclude any other additives, components, integers or steps. Likewise, the term "comprising" is considered synonymous with the terms "including" or "containing" for applicable legal purposes. Any discussion of documents, acts, materials, devices, articles and the like are included in the specification solely for the purpose of providing a context for the present invention.

**[0018]** In this disclosure, whenever an element or a group of elements is preceded with the transitional phrase "comprising", it is understood that we also contemplate the same element or group of elements with transitional phrases "consisting essentially of, "consisting", "selected from the group consisting of”, "including", or "is" preceding the recitation of the element or group of elements and vice versa.

**[0019]** Supercapacitors are used in applications rather than long-term compact energy storage in automobiles, buses, trains, cranes and elevators, where they are used for regenerative breaking, short-term energy storage or burst mode power delivery. Supercapacitors still have problems that remain since their inception.

**[0020]** Reference will now be made in detail to the exemplary embodiment of the present disclosure. Before describing the detailed embodiments that are in accordance with the present disclosure, it should be observed that the embodiment resides primarily in combinations arrangement of the system according to an embodiment herein and as exemplified in FIG. 1

**[0021]** Figure 1 illustrates the block diagram of design and analysis of battery supercapacitor hybrid electrical energy storage systems for regulation services

100. The proposed system 100 includes a supercapacitor 101 which is replaced with various supercapacitor materials to analyze their efficiency. The battery pack 104 will utilize the energy through electrical bus 103 and DC-DC converter 102. The electrical drive system 105 which is a system embedded in hybrid system is analysed after its efficiency through transmission 106. The deep learning unit 107 will monitor the energy efficiency and stores the result on resultant unit 108.

**[0022]** In the following description, for the purpose of explanation, numerous specific details are set forth in order to provide a thorough understanding of the arrangement of the system according to an embodiment herein. It will be

apparent, however, to one skilled in the art that the present embodiment can be practiced without these specific details. In other instances, structures are shown in block diagram form only in order to avoid obscuring the present invention.

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Date: 08/10/2022

# WE CLAIM

1. Design and Analysis of Battery Supercapacitor Hybrid Electrical Energy Storage Systems for Regulation Services comprises of

Deep learning unit; Supercapacitor; Battery and Electrical device.

1. Design and Analysis of Battery Supercapacitor Hybrid Electrical Energy Storage Systems for Regulation Services, according to claim 1, includes a deep learning unit, wherein the deep learning unit for analysing the importance of supercapacitors in hybrid electrical energy systems.
2. Design and Analysis of Battery Supercapacitor Hybrid Electrical Energy Storage Systems for Regulation Services, according to claim 1, includes a supercapacitor, wherein the supercapacitor will support the charging of hybrid electric vehicles.
3. Design and Analysis of Battery Supercapacitor Hybrid Electrical Energy Storage Systems for Regulation Services, according to claim 1, includes a battery, wherein the battery will be charged using the supercapacitor.
4. Design and Analysis of Battery Supercapacitor Hybrid Electrical Energy Storage Systems for Regulation Services, according to claim 1, includes an electrical device, wherein electrical device will be charged using supercapacitor.

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# ABSTRACT

**DESIGN AND ANALYSIS OF BATTERY SUPERCAPACITOR HYBRID ELECTRICAL ENERGY STORAGE SYSTEMS FOR REGULATION SERVICES**

Design and Analysis of Battery Supercapacitor Hybrid Electrical Energy Storage Systems for Regulation Services is the proposed invention. The invention focuses on designing a framework for analysing of supercapacitors. The invention aims at increasing the efficiency of hybrid electrical systems. The invention also includes monitoring the regulation services.

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