Energy Management System for Electrical Vehicles and Micro Grids

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Abstract -- Micro grid is a localized grouping of electricity of sources and loads that normally operate connected to both generating and utility unit but can disconnect and function under the physical or economic conditions. Excess power can be sold back to the utility grid. In this paper we study the charging of electric vehicles from micro grids and the system was built to reduce the operating cost but also it improves the operation of micro grid.

Indexed Terms- Ultra-Capacitors, EMS, HESS, DC Converter Model.

I. INTRODUCTION

Micro grid is transforming the way, energy is being generated and distributed which led to development of eco-friendly & efficient technology such as plug in electric vehicle Electric vehicles (EVs) still have not been adopted by the masses yet. Reasons are high costs, especially of the battery and its replacements, as well as limited driving range. A solution is to adopt a Hybrid Energy Storage System (HESS), where the battery is assisted with an ultra-capacitor (UC). Ultra capacitor is kept between the ranges of 25.5V to 28.5V. The UC has high power density, but low energy density. Furthermore, the UC has a longer cycle life. Therefore, the UC handles high power peaks, relieving battery stress an0d extending battery cycle life. A form of control is required between the battery and UC. An HESS management strategy comprises two parts – power management strategy (PMS) which controls power flow, and energy management strategy (EMS) which deals with the energy levels. There are several modes for braking operation-

A). Ultra capacitors charged by the regenerative braking energy with priority.

B). UCs and battery pack are charged simultaneously.

C). UCs have been completely charged and batteries are charged by regenerative braking and energy generated by motor.

II. TYPES AND COMPONENTS

A. Types

1. Campus Environment/Institutional Micro grids: -The focus of campus micro grids is aggregating existing on-site generation with multiple loads that located in such a way that owner easily manage them.

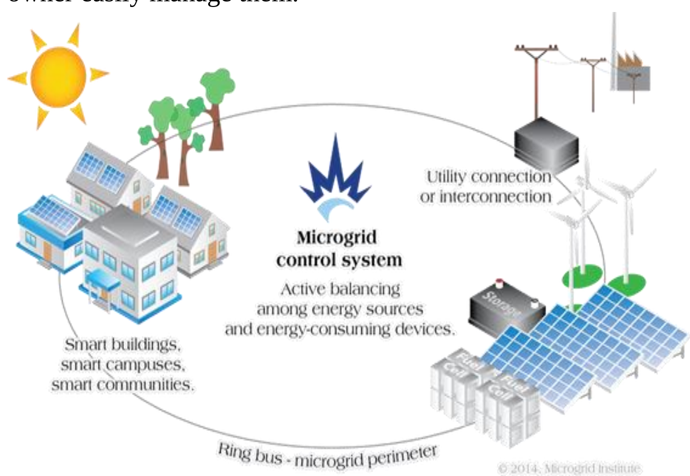

Fig – 1. Micro Grid Control System

2. Remote "Off-grid" Micro grids: -These micro grids operate in an island mode at all times because of economic issue. Typically, an "off-grid" micro grid is built in areas that are far distant from any transmission and distribution infrastructure and, therefore, have no connection to the utility grid.

3. Military Base Micro grids: -These micro grids are being actively focused on both physical and cyber security for military facilities.

4. Commercial and Industrial (C&I) Micro grids: -These types of micro grids are maturing quickly in North America and Asia Pacific.

It presents various types of generation source that feed electricity to user. These sources are divided into two major groups – conventional energy sources (ex. Diesel generators) and renewable generation sources (e.g. wind turbines, solar).

B. Components of Micro Grid

1. Consumption:-It simply refers to elements that consume electricity which range from single devices to lighting, heating system of buildings, commercial centers, etc.

*2. Energy Storage:-*In micro grid, energy storage is able to perform multiple functions, such as ensuring power quality, including frequency and voltage regulation, smoothing the output of renewable energy sources, providing backup power for the system and playing crucial role in cost optimization.

3. Point of common coupling (PCC):-It is the point in the electric circuit where a micro grid is connected to a main grid. Micro grids that do not have a PCC are called isolated micro grids which are usually presented in the case of remote sites where an interconnection with the main grid is not feasible due to either technical and/or economic.

III. MODELLING

A. HESS Topology

Since we know that the UC voltage will fluctuate significantly during usage, it is installed after a DC/DC converter to reduce voltage fluctuations in the DC bus. Therefore, this work proposes the addition of a UC to the mid-sized EV using the partially-decoupled single DC/DC converter topology shown in Fig. 2. This allows the existing EV powertrain to be kept intact as much as possible, where the original battery is left connected to the DC bus.

The new components are theDC/DC converter and the UC

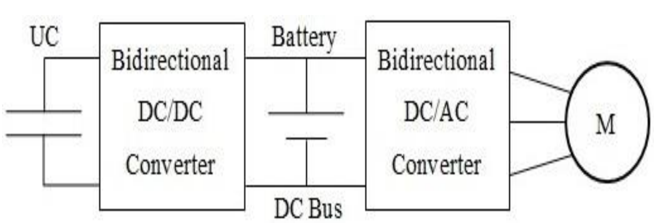

Fig- 2. DC/DC & DC/AC Converter

1. Battery & UC Model

The battery model consists of a cell of open circuit voltage in series with an internal resistor. Similarly, the UC Model consists of a capacitor in series with an equivalent series resistance. The selected UC is six Maxwell 48V general purpose modules connected in series.

2. DC/DC Converter Model

The bidirectional two-quadrant buck-boost DC/DC converter operates in buck mode when transferring power from DC bus to UC, and vice-versa for boost mode. Negative UC power values indicate the UC is being charged.

IV. HYBRID ENERGY MANAGEMENT SYSTEM

In HESS the battery is assisted with the ultra-capacitor (UC). the UC has high power density and low energy density.

It has two main parts

- Power storage/power management system
- Energy storage/power management system

An Intelligent Energy Management System for
Large-Scale Charging of Electric Vehicles.

The problem of large-scale charging of electric vehicles (EVs) with consumer-imposed charging deadlines is considered. An architecture for the intelligent energy management system (items) is introduced.

A. THE IEMS ARCHITECTURE

The iEMS architecture is illustrated in Fig. 3. The hardware system of the proposed iEMS includes a dispatcher that delivers power from a mix of energy sources—local energy (e.g., renewable energy and local storage) and purchased electricity from the grid—to tens or hundreds of chargers. Through the network switch, the scheduler activates and deactivates the chargers connected to EVs admitted to the facility to serve more urgent or more profitable requests.

The iEMS is run by the software system that makes engineering and economic decisions. At the core of the software system for the iEMS is the charging scheduling algorithm, which is the focus of this paper.

The scheduler

1) controls the power dispatcher to procure energy from available sources,
2) sets the connections of the switch so that a subset of EVs are charged by the available chargers, and
3) Determines the admission of new EVs based on its charging demand and the system operating condition. The software system also has to handle billing, other ancillary services and possibly the forecast of available

renewables in the future, which are not discussed in this paper.

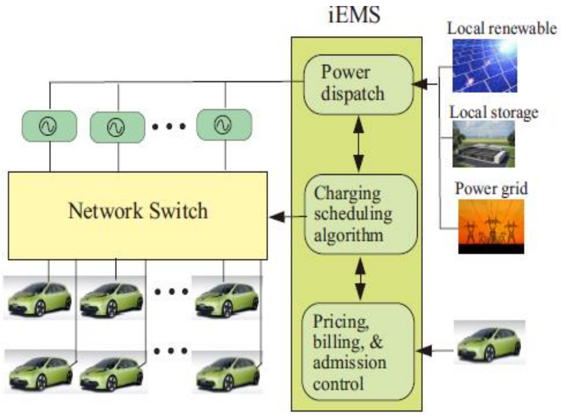

Fig – 3. iEMSArchitecture

V. ENERGY STORAGE SYSTEM

Storage systems are very essential to any micro grid because they allow the micro grid to balance the electrical. Energy storage system for micro grids combining electrical storage. Such as Lithium-ion battery system with a solar array tin the case of remote micro grid, batteries are the most common storage because the storage capacity required does not justify the higher cost of storage technologies

A. Green Energy Management System

This paper also shows the basic block diagram of the proposed green energy system. The main sources of energy in such a system are the centralized renewable energy plants. They generate renewable energy on large scale. The utility grid transmits, and distributes this energy to the end user. The residential, and commercial buildings have their own small scale power generating units. These are solar, and/or wind based units. The waste heat from industrial, residential, and commercial buildings is also collected, transported, and stored in the STES block. This heat is transported back to the industrial, residential, and commercial buildings when it is required for space heating, and cooling purposes. All these blocks are connected through information, and communication technology to a CEMS.

B. Zero Net Energy

A ZNE building is one which the net energy consumption is zero. This means that the total energy used by the building annually is approximately equal to the amount of RE created on the site. However, an Energy Plus (EP) building is one in which the total RE produced on an annual basis is more than the energy it imports from the grid. ZNE working architecture is shown in fig – 4.

1. *Industries*: -Large scale industries have their individual standalone power plants for their energy needs. Small scale industries derive their energy from the grid. The conventional standalone power plants may be replaced with CSP based power plants or other RE plants. They will supply *t*heir excess power, if any, to the grid.
2. *Residences:* -Individual residences or communities of residences will have their own power generating units based on solar, wind, biomass, and fuel cells. They will take care of the entire energy requirement of the residences. Excess of energy, if any, will be sent to the substation, for circulation in the grid.

B.1 Seasonal Thermal Energy Storage (STES)

Waste heat from air conditioning equipment, and other processes in industries, commercial complexes, power plants, and residences is transported to a Seasonal Thermal Energy Storage (STES) unit. Natural cool, and heat of the atmosphere is also collected, and stored. This is done through pipes carrying working fluids to a thermal reservoir where the heat can be stored up to months. This serves the district heating, and cooling requirements. Thus, the space heating, and cooling problems are taken care of by the STES unit.

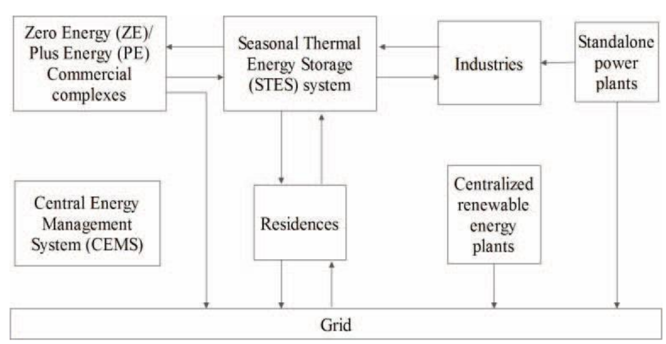

Fig – 4. ZNE Architecture

B.2 Central Energy Management System (CEMS)

A CEMS is branched into a few Regional Energy Managers (REMs) which further branch into Energy Managers (EMs) at the state levels, and at the local levels. These will supervise, and control the state of energy, and demand at different areas so that energy can be suitably dispatched, and diverted. All communications take place through wireless communication techniques. Managing this energy flow effectively is important to strike the perfect balance between the power demand, and supply. Thus, this central body is developed to automatically detect issues, and manage them effectively; the reliability of the grid will be increased. The CEMS controller is developed based on the fuzzy rough set theory.

VI. CONCLUSION

In this paper we analyzed a hybrid power supply system, ultra-capacitor and batteries for extending the driving mileage and efficiency of electric vehicles. The main objective of this paper is to provide an optimal energy management system. The admission problem for electric vehicle with deadlines and choice of energy is considered. Integration of electric vehicle with micro grid bring about an evolution in existing grid. This will increase the local power generation, thereby reducing the congestion on the grid.

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