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Intelligent Charger for Electric Vehicle

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Abstract: - this paper concerns with Vehicle to grid power flow and Grid to Vehicle power flow. For latest intelligent charger inputs required are Battery and Solar Panel. In an electric Vehicle the role of batteries comes under the action from starting ignition to off the vehicle under the complete rest condition. It is required to maintain High "State of Charge"(SOC) of the vehicle battery for achieving vehicle to grid power flow. The intelligent charger should be capable of charged the battery and once the battery is fully charged power is pumped the grid.

Keywords: - Battery Charger; Electric Vehicle; Vehicle to grid; energy storage system, V2G Operation

I. INTRODUCTION

In recent years, the researches on effective use of battery energy have been increased according to the market expansion of electric vehicle (EV) using batteries as energy source. Due to the increasing needs for electric power in EVs, battery energy conditioning systems are required for charge and discharge control of the batteries [1].The peak-load condition could be occurred in day- time from 10 a.m. to 12 p.m. or from 4 p.m. to 6 p.m. when is swamped with electric power demand in factories or buildings. Because of the quantity of demand power depends on the power consumption of loads, the utility grid has to secure a supply of electric energy which is larger than the required power consumption under peak load-condition. It means that the waste of electric power could be heavy at the other time than peak-load period.

In this paper, rapid-charger system which has a function of load compensation at the peak-load condition is proposed [1]. At the peak-load condition, the intelligent charger transfer charged energy in the battery of electric vehicle to the grid (V2G).

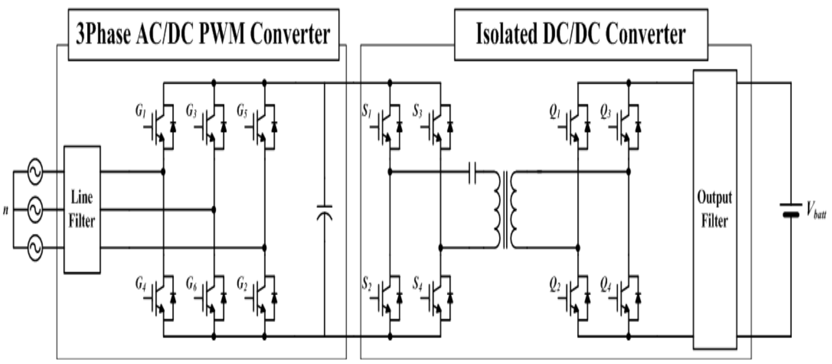

Figure: 1 Intelligent-charger system schematic diagram.

As shown in Fig. 1, propose rapid-charger system the well-known two-stage power converter which is composed of AC-DC PWM converter and an isolated bidirectional DCDC converter [1].

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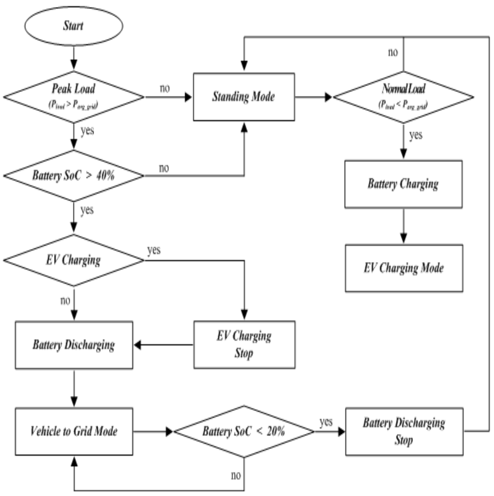
II. PROPOSED CHARGING-DISCHARGING SEQUENCE

Figure: 3 shows the proposed power flow determination algorithm for rapid-charger system including V2G mode. At the peak-load condition, the system controller checks the rapid-charger operational state (i.e. charging or discharging). Fig 4 shows the each mode of operations.

V2G mode (Discharging mode) — When the peak-load condition is recognized, the battery state of charge (SOC) is detected by the system controller. In the proposed sequence shown in Fig. 3, the intelligent charger starts to operate the V2G mode when the battery SOC is above 40%. V2G mode continues until 20% of SOC, and the intelligent charger is operated under the standing mode below 20% of the battery SOC.

Standing mode (Sleep mode) — At the beginning of peak load condition, if the battery SOC detected by the system controller is below 40%, the intelligent charger operates under the standing mode. During the peak-load condition, both of the charging and discharging operation is not performed.

Charging mode — after the peak-load condition (i.e. normal-load condition), the battery charging operation can be performed. When battery SOC is below 40% and grid power is larger than load power demand, the rapid-charger operates under the charging mode



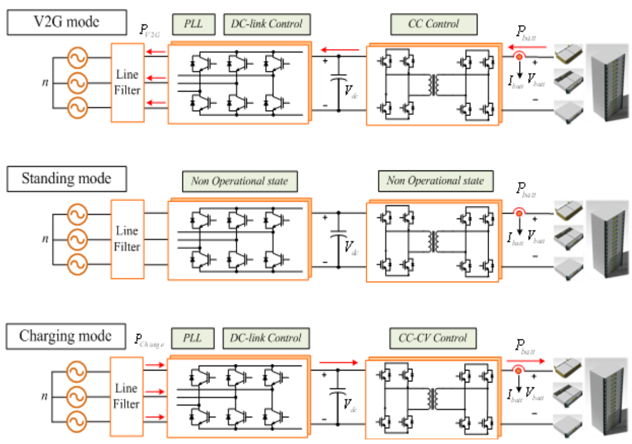


Figure: 2 Intelligent-charger system algorithm flowchart

Figure: 3 The each mode of operations in Intelligent-charger system

A. The Relationship between Generated Power and Battery Power according to the Load Power

According to the increasing power consumption, more power generation is needed at the peak-load. When the power demand for loads is smaller than generated power from the utility grid, the excess power of grid charges the battery. In case of the power demand is larger than generated power, such as the peak-load condition, the intelligent charger transfer the energy stored in batteries to the utility grid to share the power demand for loads.

During the peak-load condition, the relationship between the load power, *Pload*, and the averaged grid power, *Pavg_grid*, can be represented as (1).

$$P_{load} > P_{avg\_grid} \qquad (1)$$

The maximum required power of V2G mode, *PV2G*, during the peak-load condition is shown in (2). The *PV2G* can be expressed as the capacity of the battery, *Pbatt*, in kWh divided by the time interval of peak-load condition, *tpk*, as (3).

$$P_{V2G} = P_{load} - P_{avg\_grid} \qquad (2)$$

$$P_{V2G} = \frac{P_{batt}}{t_{pk}} \qquad (3)$$

When the averaged grid power is larger than load power demand as expressed in (4), the intelligent charger operates under the charging mode. The possible charging power, *PCharge*, can be written as (5).

$$P_{avg\_grid} > P_{load} \qquad (4)$$

$$P_{Charge} \leq P_{avg\_grid} - P_{load} \qquad (5)$$

B. Batteries:-

1. Nickel Metal Hydride batteries(Ni-MH)

   Nickel-metal hydride batteries are essentially an extension of the proven sealed nickel-cadmium battery technology with the substitution of a hydrogen-absorbing negative electrode for the cadmium-based electrode.

   General Characteristics

   - Typically can be recharge hundreds of times.
   - Efficient at high rate discharges.
   - Significantly higher capacity than nickel-cadmium batteries.
   - Typical expectancy life is 2 to 5 years
   - Operates well at a wide range of temperatures:
     Charging - 0° C to 50° C
     Discharging - 0° C to 50° C

2. Lithium Ion Battery(Li-Ion)

   In these batteries, carbon material is used in the anodes and a metal oxide material containing lithium is used in the cathodes; lithium ions migrate between the two electrodes via an organic electrolyte. By designing these batteries in accordance with the reversible capacity of the carbon material, lithium does not exist in the metallic state during either the charging or discharging processes.

   General Characteristics

   - Comparatively lighter in weight than Ni-MH
   - Life of the battery is comparatively less.
   - Difficulty: High Capital Cost

C. Future view

For Proposed topology, role of single car becomes insignificant. Presumption required for 2020

- Total Electric Vehicles= 1 Lakh
- solar Powered Electric vehicles=30,000
- Single Electric Vehicle =408 watts
- Total : 30,000 x 408 = 12.24 Mw

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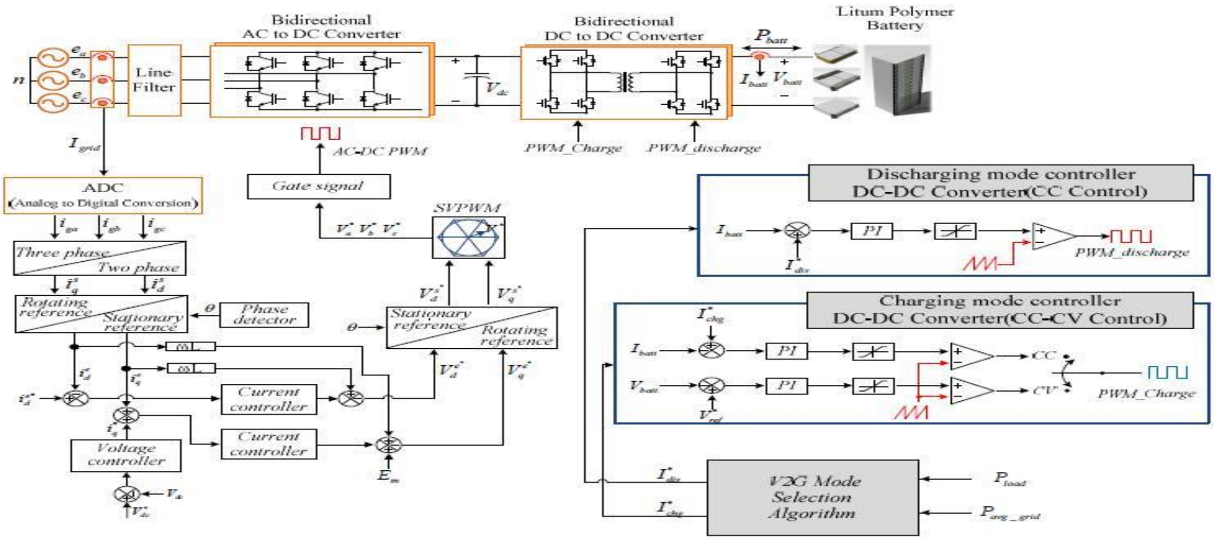
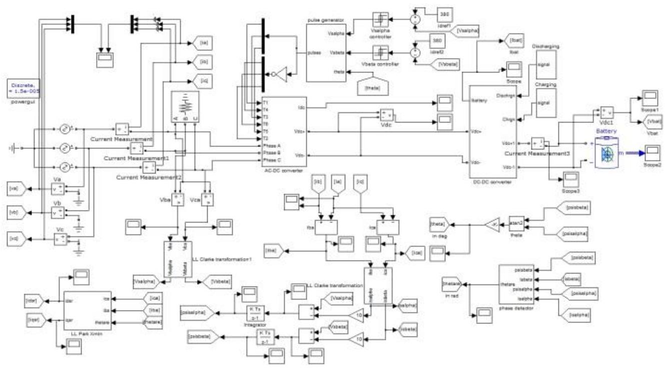


Fig. Intelligent charger Charging- Discharging Control Block Diagram

III. METHODOLOGY

Figure: 4 Block Diagram of Intelligent Charger Charging-Discharging Control

IV. SIMULATION RESULTS



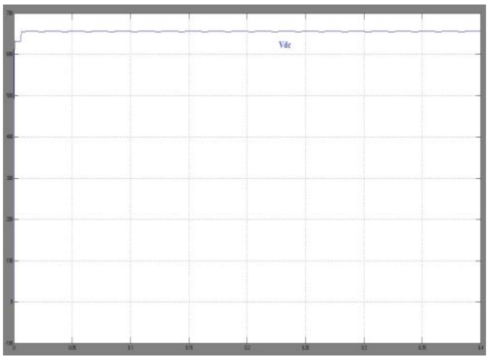


Figure: 5 Simulation Block

Diagram Figure: 6 Output DC Voltage

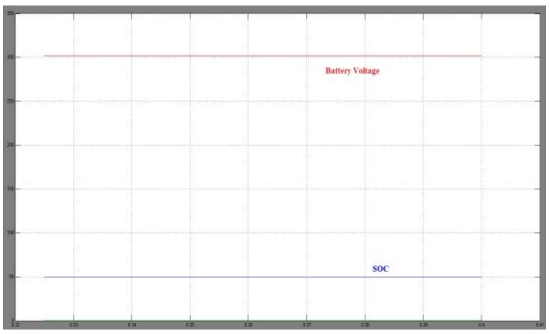


Figure: 7 Battery Output Voltage

V. CONCLUSION

In this paper, for electric vehicle considering vehicle to grid is presented. Under the peak-load condition, the sequence and the control method of battery charging and discharging for the rapid-charger is proposed. Now days, Vehicle to Grid energy Transactions are picking up. The scheme proposed is supposed to support the Grid.

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