Next Generation Automation Architecture for DC Smart Homes

A term paper report Submitted in partial fulfillment of the requirements for the award of degree of

**BACHELOR OF TECHNOLOGY**

**In**

**ELECTRICAL AND ELECTRONICS ENGINEERING**

By

**M. SAI CHAND 14006110**

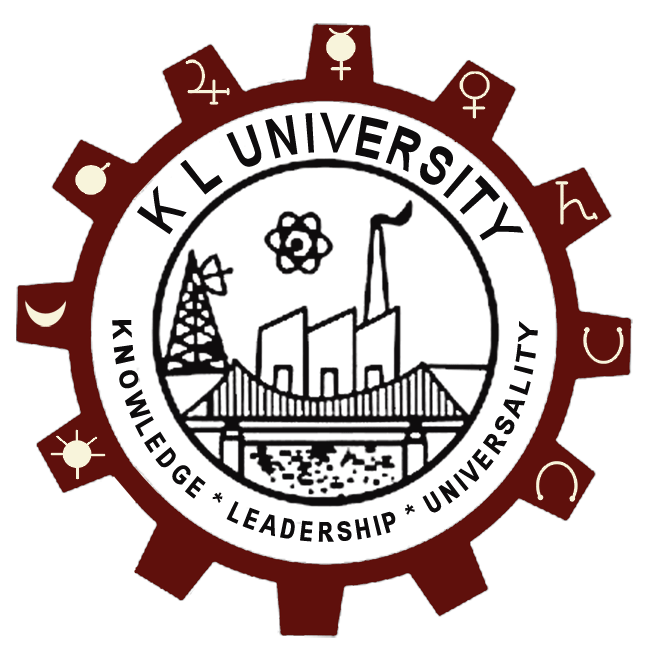
**B. SIDHARTH SARAT RAJ 14006128**

Under the esteemed guidance of

**MS. B. JYOTHI**

Assistant Professor

EEE Department



**DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING**

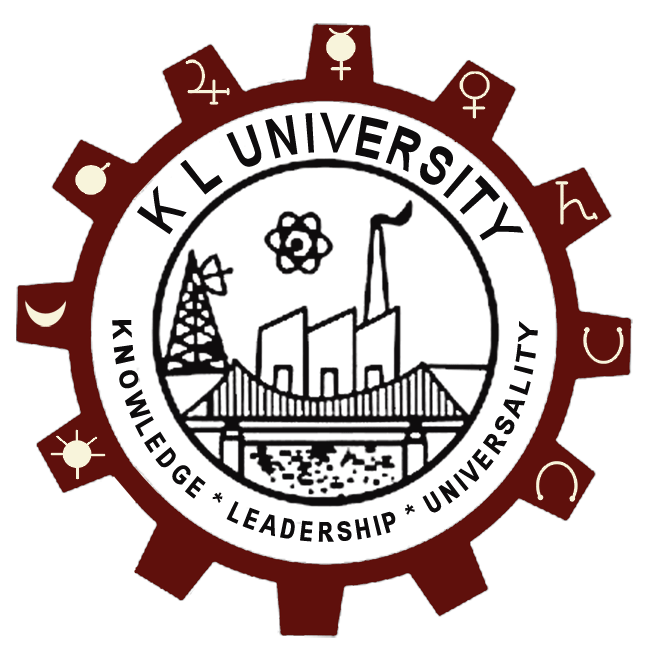
**K L UNIVERSITY**

Green Fields, Vaddeswaram, Guntur district, A.P - 522 502.

**2016-2017**

**K L UNIVERSITY**

**DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING**



**CERTIFICATE**

This is certified that the term paper entitled **“Next Generation Automation Architecture for DC Smart Homes”** which is a experimental and theoretical and Simulation work carried out by **M.SAI CHAND (14006110), B. SIDHARTH SARAT RAJ (14006128)** in partial fulfillment for the award of the degree of **Bachelor of Technology** in Department of **ELECTRICAL AND ELECTRONICS ENGINEERING**, during the year 2016-2017. The term paper has been approved as it satisfies the academic requirements.

**Term paper Guide Head of the Department**

**Ms. B Jyothi Dr.O.CHANDRA SEKHAR**

**ACKNOWLEDGEMENT**

The satisfaction that accompanies that the successful completion of any task would be incomplete without the mention of people whose ceaseless cooperation made it possible, whose constant guidance and encouragement crown all efforts with success.

We are grateful to our term paper guide **Ms. B. Jyothi** Assistant Professor, Electronics & Electronics Engineering for the guidance, inspiration and constructive suggestions that helped us in the completion of this paper.

At the outset we thank our Head of the Department, **Dr. O CHANDRA SEKHAR** for the moral support and the excellent facilities provided .We would also like to thank all the teaching and non-teaching staff members of Electrical and Electronics department who have extended their full cooperation during the course of our term paper.

We thank all our friends who helped us in sharing knowledge with us

**M.SAI CHAND 14006110**

**B.SIDHARTH SARAT RAJ 14006128**

**ABSTRACT**

DC nanogrids for residential use are gaining point as an effective solution to integrate several types of distributed renewable energy resources, energy storage, and DC loads .This paper proposes novel three-layer automation architecture for the DC nanogrid of future DC “smart” homes .The bottom layer, i.e. the converter level control, is fully decentralized and allows plug-play functionality, without the need for extra communication .The middle layer optimizes the usage of energy resources and storage as well as thermal (heating/cooling) .The top layer is the user interface and the communication port to the Energy Network Operator, to enable smart grid capabilities, such as demand side management, demand response, and grid support .This paper presents the draft architecture together with a preliminary analysis of standard protocols for building automation which can be used to identify the best solutions for the communication that supports the architecture .

**INTRODUCTION**

To monitor and control the renewable energy resources and storage systems in a DC nano grid, automation architecture, supported by information and communication technologies, must be designed .The automation architecture must also be able to monitor and control the building's heating and cooling, ventilation, and lighting systems as well as safety (eg .fire, flooding, etc .) systems .Moreover, the automation architecture must have a smart link to the Energy Network Operator (ENO), Aggregator, or Third Parties .The electrical and heating components the automation architecture monitors and controls as well as communication medium and protocol standards have to be chosen in a way that they support the upcoming trend towards the construction of grid supportive buildings, as explained in .It should be noticed that the adoption of DC technology imposes newer and more stringent requirements compared to the counterpart AC technology, as Emerge Alliance has shown in recent years. Centralized and decentralized architectures for domestic (or building) automation have been proposed in literature .The first type is the centralized control .The advantages of the centralized approach are the simple implementation of the energy management strategies and an easy prioritizing of the energy scheduling .The major drawbacks of the centralized control are the impossibility of plug & play of new resources (if this requires reconfiguration of the main algorithm), and the difficulty to be fault tolerant of an element .The decentralized control for DC nano grids is mainly based on the droop control to integrate different resources with current sharing, which in general does not need communication, thus helping the system robustness .With droop control in DC grids, the bus voltage serves as an information carrier of the load level .Specifically, as described in , variations of the load lead to variations of the bus voltage, which can be used to coordinate the mode of operation (voltage or current mode) of the converters in the nano grid .Another attractive decentralized architecture for energy management proposed in literature relies on a Multi-Agent System (MAS), where each agent provides to its own converter the control mode (voltage or current) and, when needed, the current reference based on the load demand .This solution has the main advantage of being suitable for energy optimization purposes .

**ADVANTAGES OF DC OVER AC IN BUILDING APPLICATIONS:**

DC systems, in principle, offer higher efficiency, higher flexibility and lower component cost compared with AC counterpart .The structure of the power system of a house with AC and with DC distribution is shown in Fig .1 .In a conventional AC home, a rectification stage (marked in red) is usually required to convert AC to DC for each load, which is usually

 relatively bulky, costly, less efficient and complex to control .Moreover, to feed various loads, the DC voltage needs to be further stepped down for DC loads or converted to adjustable AC voltage for AC loads .In a DC system the rectification stage is not required. So, the whole system can have much fewer power conversions and therefore an increased efficiency compared to the AC system is obtained .

***Power Architecture of the DC Smart Home***

The presence of the renewable energy resources, storage, and a more efficient DC system (compared to the counterpart AC) offer the opportunity to reduce the net energy consumption from the utility grid .To realize this, the DC nanogrid must have

1) the capacity of renewable at least equal to the net required energy utilized in the DC home (under favorable climate conditions for PV),

2) a storage able to provide energy balance,

3) a bidirectional grid connection, and

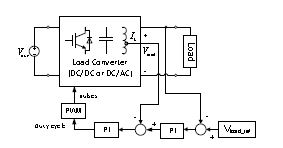
4) the ability to work in islanded mode as well as in grid supplying mode.

The scenario of the DC nanogrid envisioned for future smart DC homes.



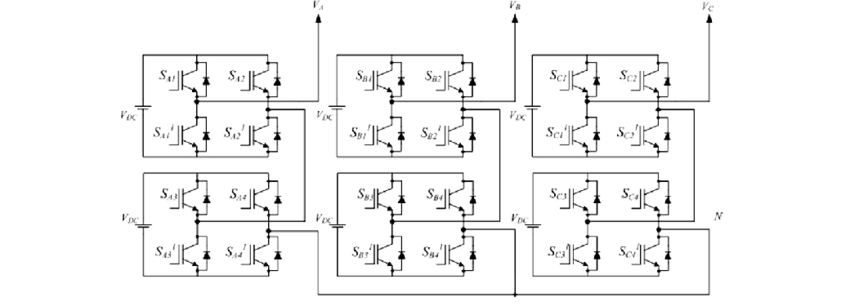
Up to now there is no standard voltage value defined for DC home systems. A very promising value would be a DC voltage level of 380 V, used in several previous works ; this voltage complies with a three-phase AC system with a line-to-line voltage of 400 V which is the standard in Europe today .Therefore, a 380 V DC bus would be compatible to systems available today, e.g. if traditional AC loads, such as fridges, stoves and other kitchens loads, washing machines, dryers, and other major home appliances, would be used in the house. It should be pointed that bipolar 􀵇380 V DC system should be considered for buildings with higher power levels, e.g. large PV system, high volume battery storage or heating demands. In addition, a low voltage (48 V) bus is present to supply mainly consumable electronics, such as computers, entertainment systems, and LED lighting.

Controlling circuit of the dc smart home:



**LITERATURE SURVEY:**

The dc smart homes implemented in this paper is all about using many renewable sources and use the power generated by it. In the present technology available, there is no scope to find a renewable source to supply the needs of all the demand of the load required so many renewable sources have to be integrated and to be made used efficiently. The present power electronics converter to be chosen . This report considers the use of wind and solar power sources as of now so the circuits taught of getting implemented to get the maximum output from the available sources are



This circuit above is cascaded h bridge inverter and this is to be integrated to and rectifier to get the dc output and extract the maximum output the usage of many number of voltage sources in this circuit makes it most convenient and efficient power converter. And to control the output voltage PI controller is used the main point to choose PI controller is that it is best suitable for steady state operations. As in this system it is efficient to use the PI controller so as the get the best results in less time. According to the survey made it has been known that people use the 40% of the electrical energy for the home cooling and lightning but with the proper use of technology and the architecture of the winds there is no need to spend a lot in there .So 40% of the energy from generated voltages can be used for rescheduled purposes.

**STORAGE AND BACKUP IN CASE OF UN PREVENTED FAULTS:**

Solar Batteries (Deep Cycle Batteries) are a key component in a stand-alone renewable energy system. If you are installing a wind, solar panel or hydro electric system that will be tied to your utility grid, you will still need **deep cycle batteries** if you are trying to use power in the event of an outage. Without deep cycle batteries, you can only use power at the time you produce it (i.e. you will not have power when the sun isn't out if you don't have batteries in your solar electric system).In renewable energy systems, deep cycle batteries provide the energy storage for your system. Unlike your car battery, deep cycle batteries that are used in renewable energy applications are meant to be discharged and recharged (cycled) repeatedly. To maintain healthy batteries and prolong battery life, most manufacturers suggest limiting the depth of discharge to about 20%. (That means the deep cycle batteries will be at 80% capacity or better.) At the very least, do not allow the batteries to be discharged below 50% Depth of Discharge (DOD). Often an inverter will have a Low Voltage Disconnect feature that will disconnect loads at a given set point. Low voltage alarms can provide audible warnings as well. Ammeters, Voltmeters, Battery Monitors can help better maintain deep cycle battery health and provide statistics about the overall health of the system.

### TYPES OF SOLAR BATTERIES:

When selecting solar batteries (deep cycle batteries), you'll have the option to use flooded lead acid (FLA) batteries or sealed batteries (AGM or Gel cell). Keep in mind that FLA batteries require a bit of maintenance, however, they generally last longer than their sealed counterparts. Water Miser Vent Cap - Reduces Battery Watering can reduce the frequency that the deep cycle batteries need watering. You'll need one vent cap for each 2 V cell. For backup there is a need to use another backup batteries which can accept the power up to 25% of the total generating capacity so that there won’t be any hurdles to use the power.

**CONCLUSION:**

The DC nanogrid features renewable energy resources, storage and loads connected to a common DC bus through power electronics converters. A peculiar aspect of the DC nanogrid, rarely presented in the literature, is the presence of a direct electrical heating system, which is presented as a new type of electrical load in addition to the DC loads (as well as traditional AC loads) .The automation architecture envisioned for future DC smart homes is designed in the form of three layers, each of them addressing different system level requirements. As main feature of this architecture, it merges advantages of classical centralized and decentralized approaches. The architecture is presented and fully described in terms of functionalities and components. A survey of standard protocols for building automation that support the communication is also given. It will be used in future works to identify the best solutions for communication.

**REFERENCES:**

1. Marnay, C.; Lanzisera, S.; Stadler, M.; Lai, J., "Building scale DC microgrids," *Energytech.*

2. Goikoetxea, A.; Canales, J.M.; Sanchez, R.; Zumeta, P., "DC versus AC in residential buildings: Efficiency comparison," *EUROCON.*

3. Shwehdi, M.H.; Mohamed, S.R., "Proposed smart DC nano-grid for green buildings — A reflective view," *Renewable Energy Research and Application (ICRERA), 2014 International Conference on.*

4. Nordman, Bruce; Christensen, Ken, "DC Local Power Distribution with microgrids and nanogrids," *DC Microgrids (ICDCM), 2015 IEEE First International Conference on.*

5. H. Harb; P. Matthes; H. Wolisz; R. Streblow; D. Müller, "Management of Electricity and Heating Demand to Match Sustainable Energy Supply," *REHVA European HVAC Journal* .

6. Official website of Emerge Alliance: http://www.emergealliance.org/Home.aspx

7. Kakigano, H.; Miura, Y.; Ise, T., "Low-Voltage Bipolar-Type DC Microgrid for Super High Quality Distribution," *Power Electronics.*

8. Sechilariu, M.; Baochao Wang; Locment, F., "Building Integrated Photovoltaic System With Energy Storage and Smart Grid Communication," *Industrial Electronics, IEEE Transactions on* .

9. Wei Zhang; Lee, F.C.; Pin-Yu Huang, "Energy management system control and experiment for future home," *Energy Conversion Congress and Exposition .*