Smart Networks for Renewable Integrated Sources for standalone Microgrids

A Mini Project Report

VII Semester

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DECLARATION

We hereby declare that the mini project entitled "SMART NETWORKS FOR RENEWABLE INTEGRATED SOURCES FOR STANDALONE MICROGRIDS" submitted as a part of mini project of VII semester submitted for the B.Tech Degree is my original work and the project has not formed the basis for the award of any degree, associate ship, fellowship or any other similar titles.

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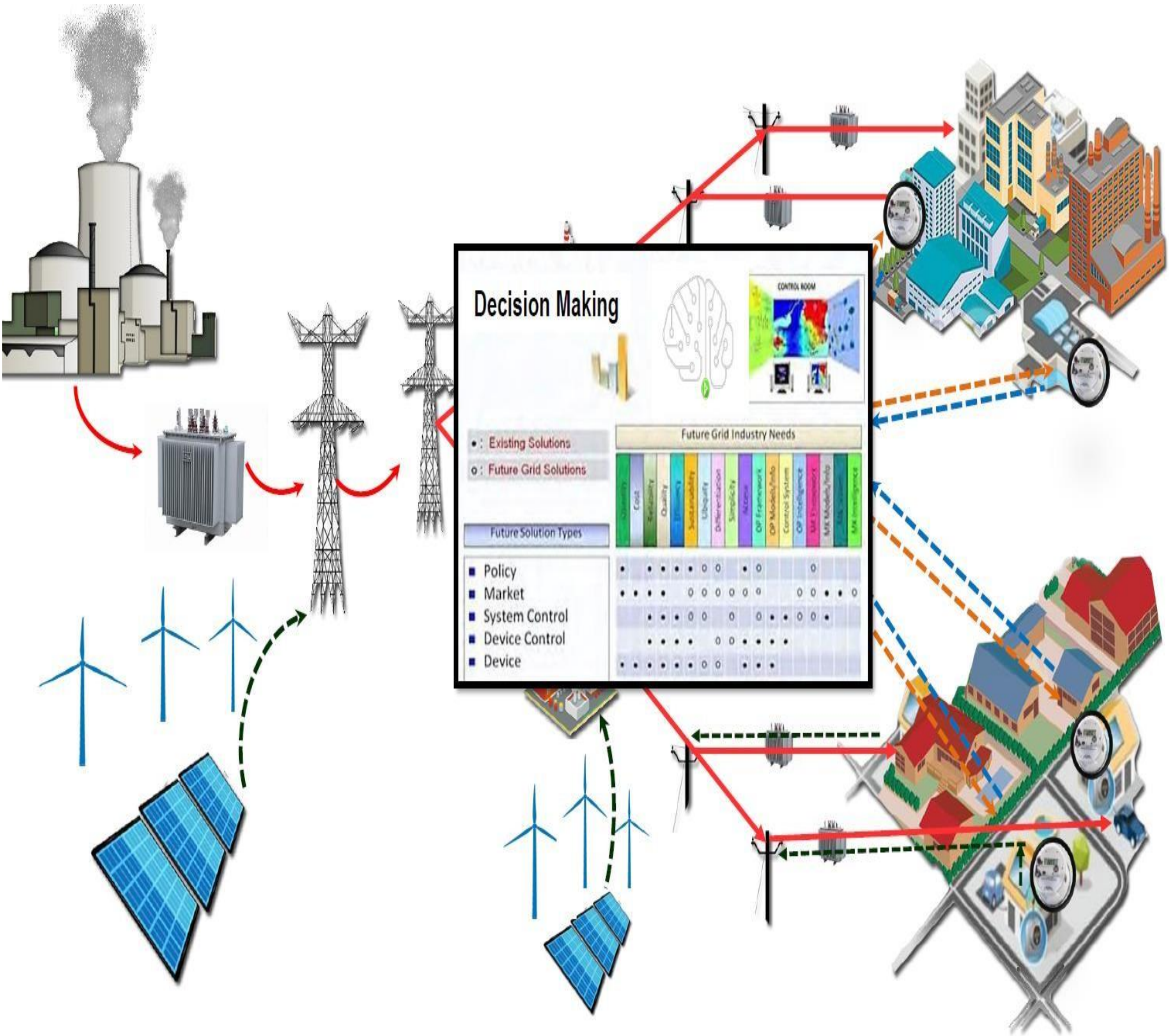
Abstract

- Microgrid is an effective way to utilize renewable energy resources, especially for satisfying the electricity requirements in remote islands.
- The operation optimization of a standalone microgrid is critical to ensure the effective performance of the whole microgrid system.
- The main contribution of this study is an operation optimization method for the stand-alone microgrid system in a remote area, which includes wind, PV, battery, and diesel generator.
- Condition monitoring, Systematic data collection, continues monitoring Performance monitoring, remedial action and cost effective manner Own remote maintenance and diagnostic units.

The development and implementation of a smart grid for power supply is one of the pressing issues in modern energy economy, given high national priority and massive investments, although the entire subject is still in its infancy stage. The smart grid delivers electricity from producers to consumers using two-way digital technology, and allows control of appliances in the consumers' houses and of machines in factories to save energy, while reducing costs and increasing reliability and transparency. Such a modern electricity network is promoted by many governments as a way of handling energy independence, global warming and security of supply. Smart meters are part of the smart grid, but do not themselves constitute a smart grid. A smart grid includes an intelligent monitoring system that keeps track of all the electricity that flows in the system. It could incorporate the use of super-conducting transmission lines to reduce losses, as well as the ability to integrate electricity from alternative sources such as solar and wind. When electricity cost is low, the smart grid can offer the customer to run intensive consumption household appliances, such as washing machines, or processes in plants that operate at flexible hours. On the other hand, smart grid at peak hours.

Graphical Abstract



Introduction

The integration of distributed generation with the main grid is called microgrid. Microgrid is the combination of small sources, like renewable energy sources, network and the loads. The inverter is main interfacing part of microgrid, and it can be considered as a source. Microgrid enhances the overall power generation and reliability of the power system. Due to use of power electronics devices, microgrid has many issues related to power quality, stability and neutral current. Therefore, it is necessary to consider the effect of source location, location of load, type of load and load parameter before the installation of microgrid. The loads can be classified as static load, dynamic load and composite load. Static loads are the algebraic function of voltage and frequency, and it is composed of constant impedance characteristics, constant current characteristics and constant power characteristics. Generally, static loads do not affect on the stability of the system because it considers only present values of the system data. One main disadvantage of the static model is that in addition to ignoring the dynamics of the dynamic load; it does not take into consideration the effect of the load inertia constant [1]. The dynamic loads affect the stability of the microgrid because it considers the present as well as historical data during performance. The load modelling of dynamic load like induction machine is to be carried out accurately for voltage stability analysis.

While planning of microgrid, it is most important to consider the composite loads. During the planning of microgrid, it is most important to study impacts of load dynamics on the stability.

Composite load modelling consists of combination of static load and dynamic load. The superiority has increased due to aggregated dynamic load representation in both small and large disturbance studies. Composite load modelling is important for accurate modelling because the dynamic model can only express the dynamic response of load model. When the influence of distributed generation is not negligible, the induction motor load model cannot effectively describe the actual load characteristic. The small signal stability framework is carried out for studying the islanded microgrid system for constant load under the different uncertainty condition. The simulation was carried on the 9 bus DC microgrid system.

In most of the literatures, only static loads or dynamic loads are considered for stability analysis of microgrid. In the present research paper, small signal stability analysis of microgrid with composite load is investigated and the results of composite load are compared with the static and dynamic load. The eigenvalue technique is used for stability analysis of microgrid [15]. The synchronous reference frame (SRF) method is considered for modelling of microgrid system. The study shows that the microgrid stability depends on the types of loads. Composite loads are more participating in stability analysis of microgrid system. Increasing the damping and inertia value within a certain limit improves the stability of microgrid.

These microgrids are generally not designed or intended to connect to the microgrid and instead operate in an island mode at all times because of economic issues or geographical position.

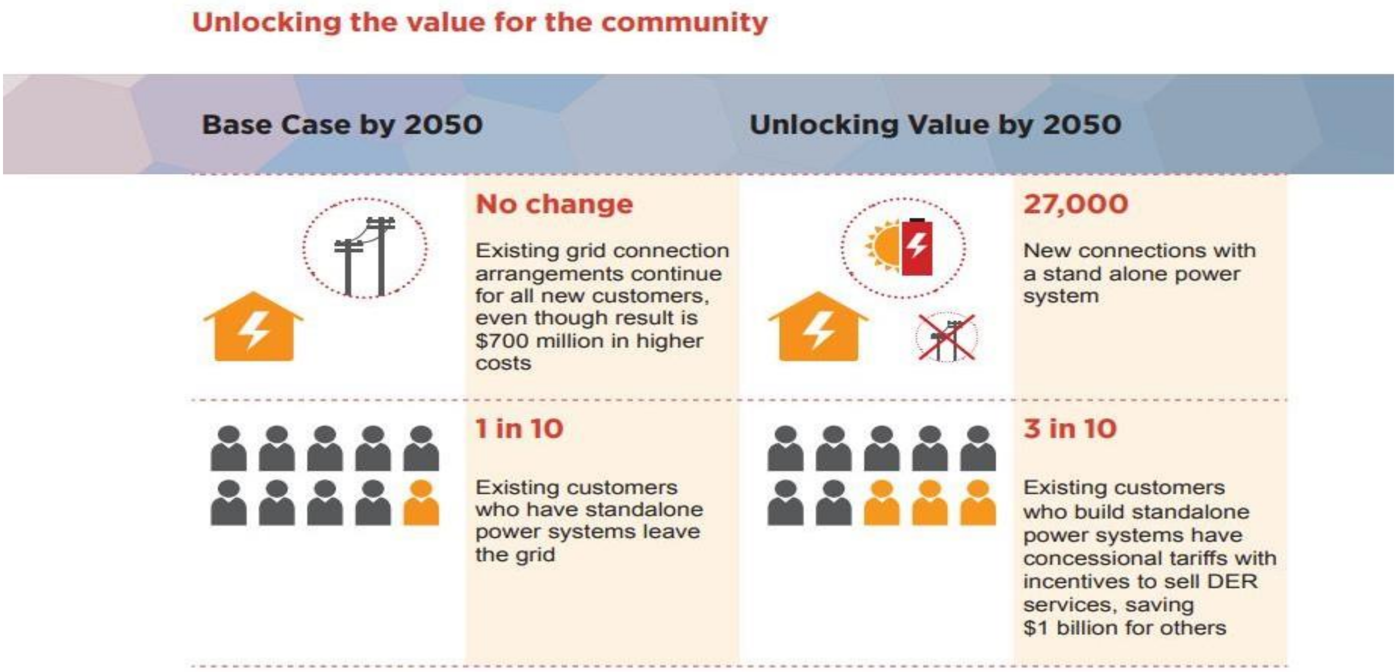
Typically, an "off-grid" microgrid is built in areas that are far distant from any transmission and distribution infrastructure and, therefore, have no connection to the utility grid. Studies have demonstrated that operating a remote area or islands' off-grid microgrids, that are dominated by renewable sources, will reduce the levelized cost of electricity production over the life of such microgrid projects. In some cases, off-grid microgrids are indeed incorporated into a national grid or 'macrogrid', a process that requires technical, regulatory and legal planning.

Large remote areas may be supplied by several independent microgrids, each with a different owner (operator). Although such microgrids are traditionally designed to be energy self-sufficient, intermittent renewable sources and their unexpected and sharp variations can cause unexpected power shortfall or excessive generation in those microgrids. Without energy storage and smart controls, this will immediately cause unacceptable voltage or frequency deviation in the microgrids. To remedy such situations, it is possible to interconnect such microgrids provisionally to a suitable neighboring microgrid to exchange power and improve the voltage and frequency deviations. This can be achieved through a power electronics-based switch after a proper synchronization or a back to back connection of two power electronic converters and after confirming the stability of the new system. The determination of a need to interconnect neighboring microgrids and finding the suitable microgrid to couple with can be achieved through optimization or decision making approaches.

Because remote off-grid microgrids are often small and built from scratch, they have the potential to incorporate best practices from the global electricity sector and to incorporate and drive energy innovation. It is now common to see remote off-grid microgrids being largely powered by renewable energy and operated with customer-level smart controls, something that is not always easy to implement in the larger power sector because of incumbent interests and older, pre-existing infrastructure.

Expected Result

- ✓ New regulatory arrangements will be required to allow innovative service deliveryfor up to 27,000 new rural connections expected to occur to 2050. Almost $700 million could be saved by supplying these connections, usually farms, with a standalone power system, yet current regulations would mandate a conventional‘grid connected’ service.
- ✓ Without better incentives, up to 10% of customers are likely to leave the grid by2050, increasing average bills to other customers by $132 per year.
- ✓ Innovative network incentives, like a Stand Alone Power System tariff, would encourage over 1 million customers to choose to stay on-grid to sell energy usingtheir own Distributed Energy Resources, resulting in lower costs for themselves andother grid customers.
- ✓ Introducing appropriate incentives for SAPS customers saves other customersaround $1 billion network bills comparedto the base case.
- ✓ Solutions which use distributed energy resources to supply energy to a group of customers (microgrids) as an alternativeto centralised grid supply can representthe lowest cost solution in some specificcircumstances.



A standalone power systems tariff provides an alternative to customers with substantial distributed energy resources, to stay grid connected while being compensated for their ability to disconnect from the grid at particular times. In addition to providing these customers additional value, these arrangements are likely to save other customers over $1 billion in network charges over the same period, equivalent to 4% per annum on average network bills with additional benefits for the distribution energy market.

Microgrids are most likely to be cost effective in the areas with the highest cost to serve, which are also the areas most subsidised under 'postage stamp' network pricing arrangements. These arrangements provide the same network tariff to rural and regional customers as urban customers and are often mandated in government regulation. Microgrid solutions are therefore challenging to implement in these areas without changes to network cost recovery frameworks and pricing. Alternative SAPS and Microgrid delivery models could still be employed by the network provider to optimise the total delivered costs to all customers. This would require the removal of regulatory barriers to these alternative delivery models.

- ✓ **Lower cost and better value** compared to complete grid defection for most customers.
- ✓ **Market access** allowing SAP customers to sell their power to the grid or to other customers. In a separate report, Energeia estimates that in 2050 up to $2.5 billion per annum will be paid to customers with DER to support the network.
- ✓ **Back up services** from the grid when the stand alone power system is down

Industries related to this technology

Energy Automation and Smart Grid

Siemens Global Pvt Ltd

Munich, Germany

Global Smart Grid Momentum

CISCO

San Jose, California, US

Smart Grid Momentum global

ABB Ltd

Zurich, Switzerland

Energy Automation and Smart Grid

Schneider Electric SE

Rueil-Malmaison, France

Energy Automation and Smart Grid

General Electric Company

Boston, US

Patent

Patentable idea & Search results

Computing Community Consortium committee of the Computing Research Association.

Randal E. Bryant Carnegie Mellon University

Computing Community Consortium committee of the Computing Research Association.

Erwin P. Gianchandani Computing Research Association

Computing Community Consortium committee of the Computing Research Association.

Randy H. Katz University of California-Berkeley

Transmission and Distribution Electrical Engineering

DrC.R. Bayliss CEng FIET, B.J. Hardy CEng FIET

Journal paper publication title

Smart Grid: The Future of the Electric Energy System

Roger N. Anderson1, IEEE member,

Reza Ghafurian2, IEEE Fellow,

Hamid Gharavi3, IEEE

Abstract-

Power grid is one of the most important manifestations of the modern civilization and the engine of it where it is described as a digestive system of the civil life. It is a structure has three main functions: generation, transmission lines, distribution. This concept was appropriate for a century. However, the beginning of the twenty-first century brought dramatic changes on different domains: media, human growth, economic, environmental, political, and technical etc. Smart grid is a sophisticated structure including cyber and physical bodies hence it reinforces the sustainability, the energy management, the capability of integration with microgrids, and exploiting the renewable energy resources. The quantum leap of smart grid is related to the advanced communication networks that deal with the cyber part. Moreover, the communication networks of smart grid offer attractive capabilities such as monitoring, control, and protection at the level of real time. The wireless communication techniques in integration frame are promised solution to compensate the requirements of smart grid designing such as wireless local area networks, worldwide interoperability for microwave access, long term evolution, and narrowband- internet of things. These technologies

SMART GRIDS COMO ALTERNATIVA DE DESENVOLVIMENTO URBANO INTELIGENTE E SUSTENTÁVEL EM PARINTINS/AM

Leslie Quitzow[1] , [2] Friederike Rohde

Abstract Current imaginaries of urban smart grid technologies are painting attractive pictures of the kinds of energy futures that are desirable and attainable in cities. Making claims about the future city, the socio-technical imaginaries related to smart grid developments unfold the power to guide urban energy policymaking and implementation practices. This paper analyses how urban smart grid futures are being imagined and co-produced in the city of Berlin, Germany. It explores these imaginaries to show how the politics of Berlin's urban energy transition are being driven by techno-optimistic visions of the city's digital modernisation and

its ambitions to become a ‘smart city’. The analysis is based on a discourse analysis of relevant urban policy and other documents, as well as interviews with key stakeholders from Berlin’s energy, ICT and urban development sectors, including key experts from three urban laboratories for smart grid development and implementation in the city. It identifies three dominant imaginaries that depict urban smart grid

Challenges, Trends and Solutions for Communication Networks and Cyber-Security in Smart Grid.

Qutaiba I. Ali , Firas S. Alsharbaty

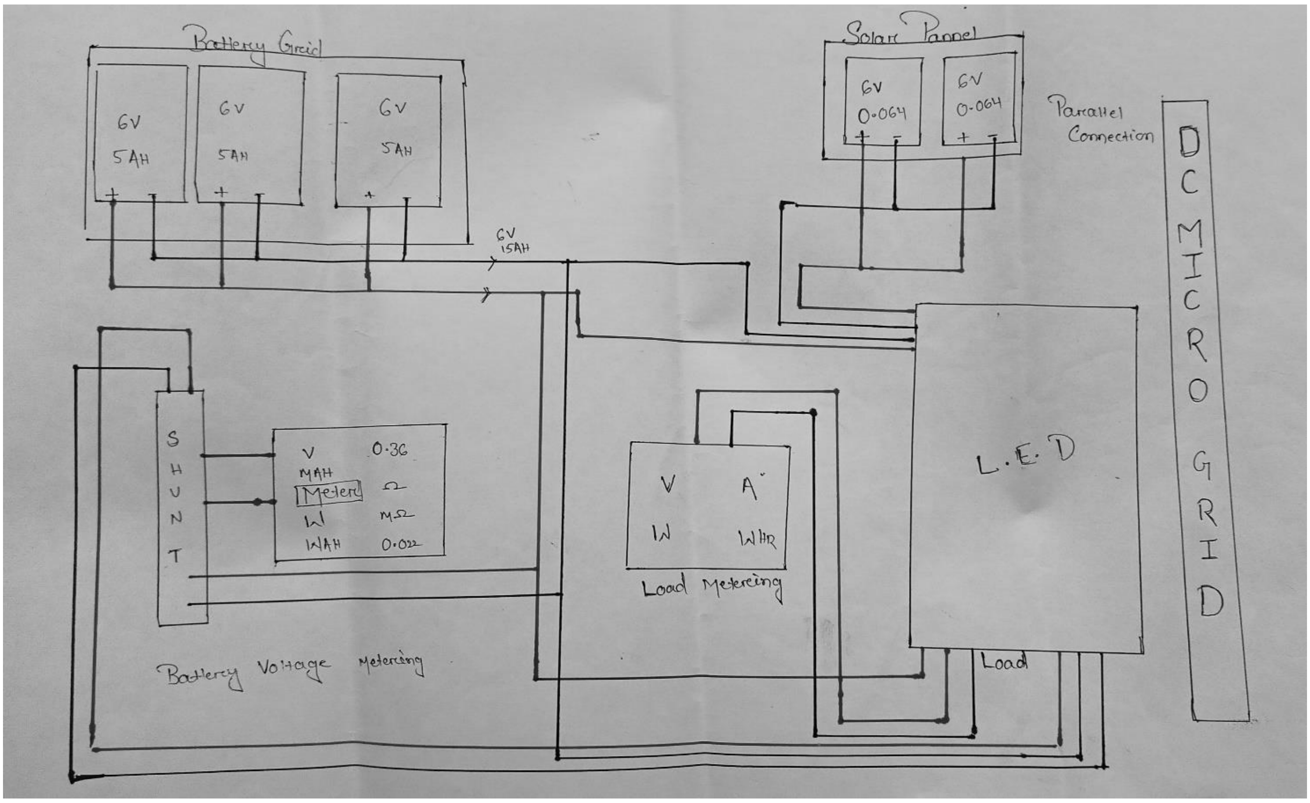
Abstract

Power grid is one of the most important manifestations of the modern civilization and the engine of it where it is described as a digestive system of the civil life. It is a structure has three main functions: generation, transmission lines, distribution. This concept was appropriate for a century. However, the beginning of the twenty-first century brought dramatic changes on different domains: media, human growth, economic, environmental, political, and technical etc. Smart grid is a sophisticated structure including cyber and physical bodies hence it reinforces the sustainability, the energy management, the capability of integration with microgrids, and exploiting the renewable energy resources. The quantum leap of smart grid is related to the advanced communication networks that deal with the cyber part. Moreover, the communication networks of smart grid offer attractive capabilities such as monitoring, control, and protection at the level of real time. The wireless communication techniques in integration frame are promised solution to compensate the requirements of smart grid designing such as wireless local area networks, worldwide

Work plan: (Plan of activities)

DC Microgrid:

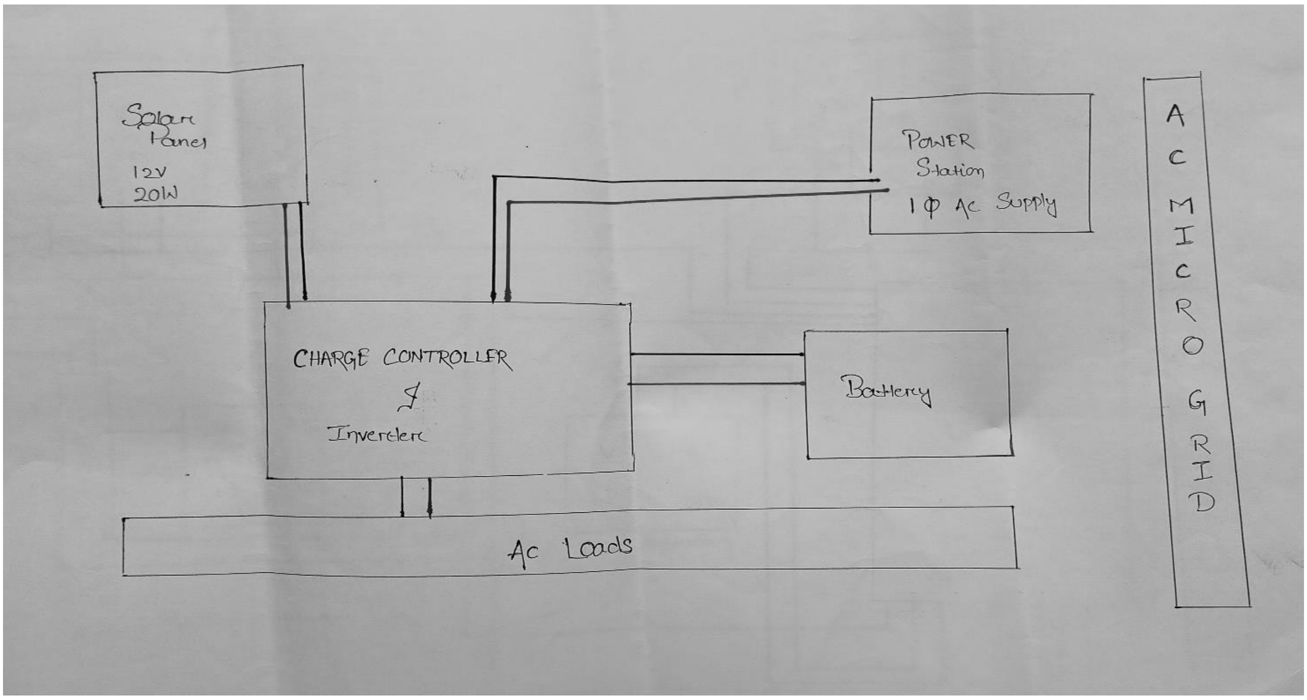
A microgrid is a small power system network, which comprises renewable energy sources, primarily the photovoltaics module, wind generation, storage systems such as batteries, supercapacitors, and loads. The concept of microgrid was put forth to meet the demand of electric energy by making it work in conjunction with the main grid or as a standalone entity. Microgrids consisting of renewable energy resources as distributed generators are a clean alternative to traditional utility grid that is driven by fossil fuels. DC microgrid can achieve expansion in power and energy production. Integration of microgrids with the utility grid will bring decentralization and digitalization in the field of electricity generation, transmission, and utilization. This chapter focuses on DC microgrids, their architecture, components of a DC microgrid, its modeling and energy management through a small case study.



AC Microgrid:

Sustainable development is the core principle of maintaining our finite but vital resources for future generations. In the context of electrical systems, sustainable development is correlated with the application and control of renewable energy resources for electricity generation instead of fossil fuels such as coal, oil, or gas. In addition, it is highly preferred to generate electricity near the consumer centers to minimize the adverse impacts on the environment when building transmission and distribution lines.

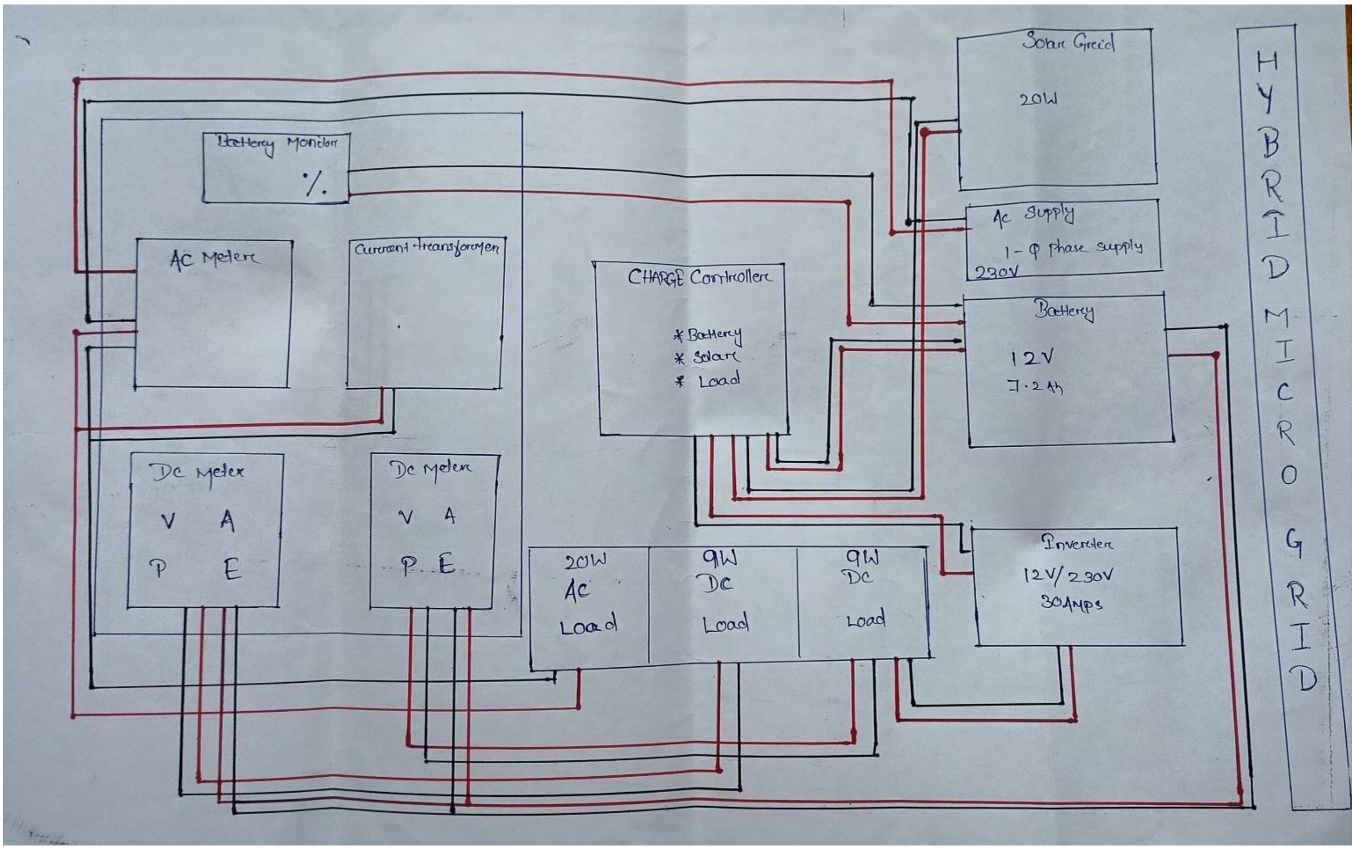
The rising electricity demand and the inevitability of reliability improvement and cost reduction are motivating the application of distributed energy resources (DERs) within distribution networks instead of expanding them.



The term microgrid refers to a small-scale electricity generation and distribution system in which a cluster of loads is supplied locally by a few DERs and/or battery energy storage systems (BESs) shows schematically a typical ac microgrid. The key feature of the microgrids is that they can operate in grid-connected mode or islanded mode (standalone) (when the grid does not exist or is unavailable provisionally). The microgrid is a promising approach to increase local renewable energy-based DERs near load centers.

HYBRID MICROGRID:

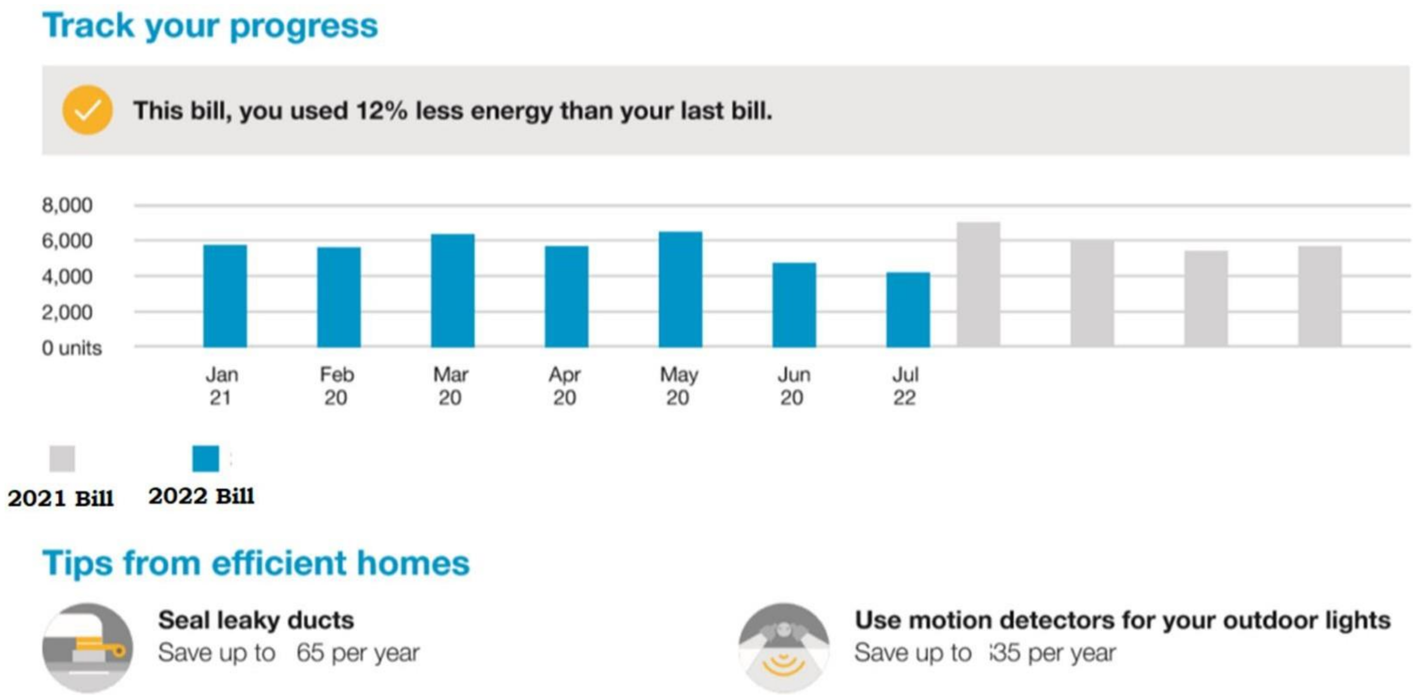
The formal definition of a microgrid is a group of interconnected loads and distributed generation sources within a clearly defined electrical boundary that acts as a single controllable entity. Microgrids themselves are not new, as diesel and gas generator sets have been sold for several decades to power remote applications. These systems are continuously becoming more fuel-efficient as engine combustion and generator technologies improve. What is new is an increase in hybrid microgrid systems that include renewable energy sources. Improvements in the costs and capabilities of photovoltaic (PV) systems, energy storage and telematics, along with advances in technology and communications, now economically justify hybrid applications that previously would have required special support or incentives. The integration of renewable technologies reduces operating expenses when compared to purely conventional generation, while also optimizing system reliability, efficiency and flexibility. The concept has become increasingly attractive as the cost of energy from wind and solar PV generation has declined. Conversely, the cost of diesel fuel – usually the most available fuel for remote locations – has risen, as shown in Figure 2. In 2000, the levelized life-cycle energy cost of wind generation was similar to that of diesel, while solar energy was nowhere near being competitive.



Control over a hybrid microgrid is simpler than controlling combined renewables and conventional generation in a major utility. On a utility grid with wholesale deployment of wind or solar energy, the intermittent nature of the renewables could make the grid unstable absent massive energy storage or spinning reserve. On a microgrid, digital controls and smaller-scale energy storage enable consistent voltage and frequency with reliable kVAR control. In the event of a voltage dip, for example, the energy storage can rapidly feed energy back into the system to provide stability. Energy storage also supports the generator sets in accepting block loads without fluctuations in frequency. This capability makes it possible to deploy renewable resources in proportions far greater than a utility grid could support – up to and exceeding total system demand. A successful hybrid microgrid deployment depends on a fully integrated system. Ideally, a single party assumes responsibility for designing the hybrid microgrid and supplying all major components

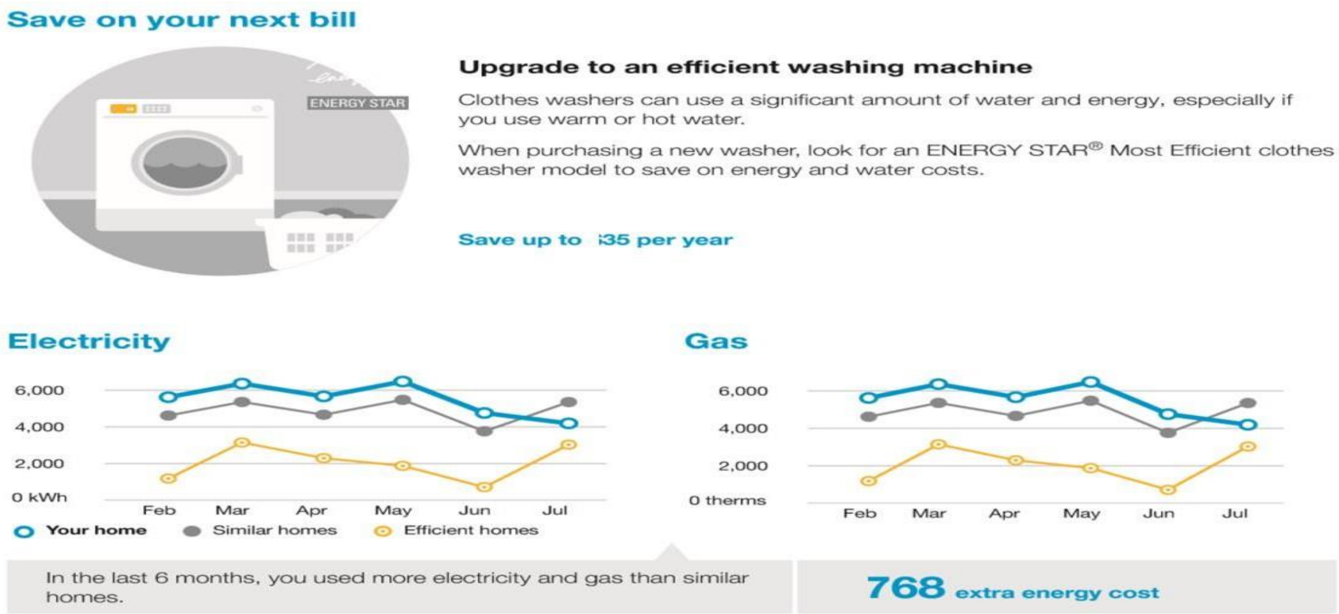
ANALYZING COSTS:

The key question is determining whether a hybrid microgrid is appropriate to a given site. Analytical tools are available that make it relatively easy to check economic feasibility. An initial high-level analysis requires little more than basic information about these several factors: • The load profile of the community or facility to be served • The site latitude and longitude and historic solar and wind conditions • The cost of fuel for the primary power unit generator sets •

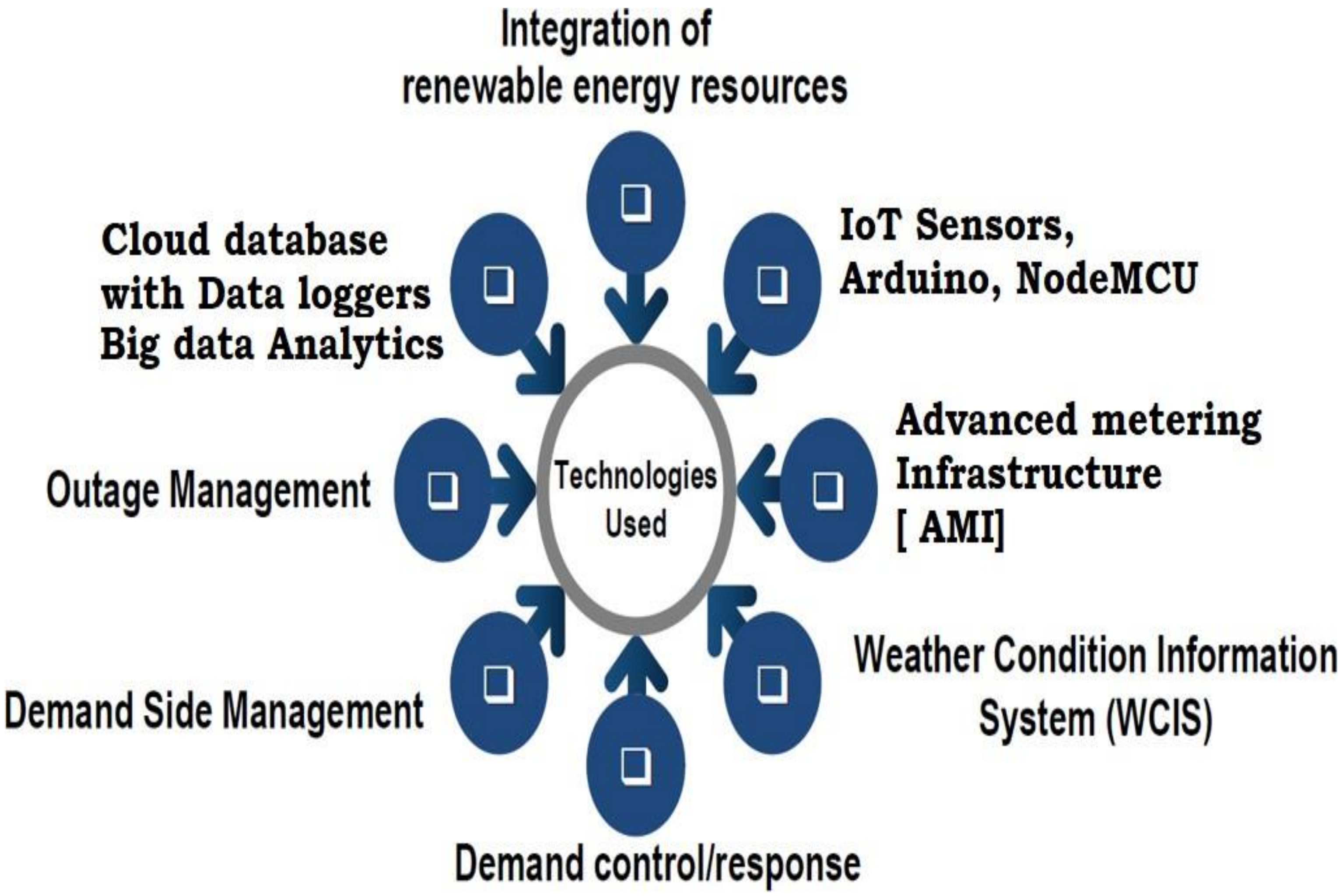


The cost of capital The results of this analysis will indicate whether a deeper investigation is warranted or whether the project should be abandoned. HOMER microgrid analysis software can be used to perform a much more rigorous analysis for making a final decision. This software simulates one year of system performance, uses site-specific solar and wind energy data, and predicts annual hours of operation and fuel use for generator sets. The resulting data can then be used to develop an operating protocol that enables financial optimization of the system.

One way to simplify a project is to select a partner with deep experience in power systems, specifically hybrid microgrids. This partner should demonstrate experience in installing and integrating these systems and employ locally based service technicians who can provide support ranging from basic planned maintenance to comprehensive long-term service agreements. The ideal organization should be qualified to manage whole-project engineering, procurement and construction, while supplying all major components and ancillary equipment.



Technologies Used to solve "Problem Statement"



Real time working prototype model made by our team

OUR TEAM


SMART INDIA
HACKATHON
2022
#InnovationSeAtmanirbharBharat

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