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Optimized Hybrid Renewable Energy to be Grid-Connected-A Smart Energy Scenario in India

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***Abstract*— This research has illustrated the integration of hybrid renewable energy resources through an Intelligent Controller System to optimize the hybrid renewable resources of solar-wind-bio available at Moushuni Island of Sundarbab-West Bengal, Eastern part of India as a case analysis. The objective is to integration of hybrid renewable plant after optimization to the nearest conventional electric grid and deployment of smart Service-Oriented-Architecture (SOA) of hybrid energy system in the user-centric pervasive computing concept in the context of Kyoto Protocol for sustainable development of the rural and urban sector. The research also illustrated on how Energy Service Companies(ESCOs), and ESCOs groups and ESCOs chains or e-energy service companies in the Smart-Grid network can optimize the national power shortage problem in peak demand period. This proposition also helps to minimize the adverse challenges of climate change utilizing renewable energy resources at this service value network integrating into repository of conventional energy resources, thus reducing carbon dioxide (CO_2) emissions percentage and ultimately enhancing a green power scenario. By feeding renewable electricity to the utility grid through grid-connected hybrid renewable energy system, during time of peak demand, sufficient electrical loads can be shed to prevent turning on conventional power plants and therefore save CO2 emissions and potentially energy import costs, replacing fossil fuels. Also, a concept of next generation mobile smart-grid city can be proposed in future, which with the chain of ESCOs with energy conservation (ENCON) measures can reduce CO_2 emission ultimately.**

***Keywords*— Smart-Grid; Pervasive Computing; Service Oriented Architecture; Energy Service Companies; Hybrid Renewable Energy Systems; CO_2 Emission.**

I. INTRODUCTION

This paper has focused on the integration of hybrid renewable energies, specifically the solar, wind & bio-mass energy resources into conventional electric grid and deployment of smart architecture of hybrid energy system in the user-centric pervasive computing concept [3],[4] in the context of Kyoto Protocol for sustainable development of the rural and urban sector[3],[4]. A concept of next generation mobile smart-grid city for efficient real-time collaborative use of renewable and non-renewable energy sources at smart user-centric device for sustainable green environment in the context of climate change is proposed for future research.

A case analysis has been performed with an objective to ensure the reliability and efficiency of the hybrid renewable system to optimize the utilization of the hybrid renewable energy sources at Moushuni Island of Sundarbans-West Bengal-Eastern part of India. A Grid Interactive Operation of Solar Photo Voltaic (SPV) System-the intelligent controller for optimization of the available intermittent renewable solar, wind, bio-mass resources at exiting operating plant of Moushuni Island has been proposed at Moushuni Island.

This paper illustrates the deployment of Energy Portal (EP) for Renewable Energy Resources based on Service-Oriented-Architecture (SOA) technology. This EP based on Business Information Warehouse, will be utilized as Decision Support System for Energy Service Companies (ESCOs) and the Energy Information System Manager as well as the Enterprise Management System in the peak load time to utilize renewable energy resources to reduce power failure, to take decision about resource utilization of renewable energy resources in present global scenario of creating a pollution free environment based on Kyoto Protocol (The Kyoto Protocol is a protocol to the United Nations Framework Convention on Climate Change (UNFCCC or FCCC), an international environmental treaty with the goal of achieving "stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system”). Also utilization of SOA for hybrid renewable energy systems to be connected to the National Power Grid has been analyzed through topologies.

A. Pervasive Computing in the context of Renewable Energy Integration into Electricity Grid –Smart-Grid

Pervasive computing is a rapidly developing area of Information and Communications Technology (ICT). The term refers to the increasing integration of ICT into people’s lives and environments, made possible by the growing availability of microprocessors with inbuilt communications facilities. Pervasive computing has many potential applications, from health and home care to environmental monitoring and intelligent transport systems. The idea that technology is moving beyond the personal computer to everyday devices with embedded technology and connectivity as computing devices become progressively smaller and more powerful. Also called ubiquitous computing, pervasive computing is the result of computer technology advancing at exponential speeds - a trend toward all man-made and some natural products having hardware and software. Pervasive computing goes beyond the realm of personal computers: it is the idea that almost any device, from clothing to tools to appliances to cars to homes to the human body to your coffee mug, can be imbedded with chips to connect the device to an infinite network of other devices. The goal of pervasive computing, which combines current network technologies with wireless computing, voice recognition, Internet capability and artificial intelligence, is to create an environment where the connectivity of devices is embedded in such a way that the connectivity is unobtrusive and always available.

This paper provides an overview of application of pervasive computing in energy and environment for sustainable development through hybrid renewable plants integration into national grid after optimization through inelegant controller proposed to be installed at Moushuni Island of Sundarban-West Bengal-Easter Part of India. The vision is towards smart-energy scenario through service value network of Energy Service Companies (ESCOs) to feed renewable energies to the grid after grid-integration of hybrid renewable plants to reduce CO_2 emissions in environment. Service-Oriented-Architecture (SOA) is deployed for this integrated hybrid renewable energies to the grid. This is a research towards smart decision support system where in the smart-grid scenario, the peak load demand can be controlled through a single entry point in network of ESCOs to utilize hybrid renewables.

By feeding renewable electricity to the utility grid through grid-connected hybrid renewable energy system, during time of peak demand, sufficient electrical loads can be shed to prevent turning on conventional power plants and therefore save CO2 emissions and potentially energy import costs, replacing fossil fuels.

II. Changing Smart Energy Scenario

Visions are: (i) “Use of advanced technologies to improve the performance of electric utility systems to address the needs of society.” (ii) “A fully automated power delivery network, ensuring a two-way flow of electricity and information between the power plant and appliance, and all points in between. Its distributed intelligence, coupled with broadband communications and automated control systems, enables real-time transactions and seamless interface among people, buildings, industrial plants, generation facilities and the electric network.” - U.S. Department of Energy Grid 2030.(iii)“Its foundation is new distributed data communication, computing, and control technologies – efficient transfer of data and control from/to/among many field units.”[8]

III. Background of Research

Renewable Energy Integration into Competitive Electricity Industries: Growing concerns about climate change and energy security have heightened interest in harnessing renewable energy resources as a response to these critical issues (Ackerman 2006; Bauer and Mastrandrea, 2006; Energy Watch Group 2006 & 2007; Galvin Electricity Initiative, 2006; Hansen, 2005; IPCC, 2007; Stern, 2006). The most important renewable energy resources are bio-energy, hydro, geothermal, wind, solar and (in the future) ocean energy systems (International Energy Agency-IEA, 2006). Thus we need to consider the integration of renewable energy within the broader set of challenges facing modern electricity industries, where price and technical performance are critical issues as well as energy security, environmental sustainability and enhanced end-use efficiency (e.g. Doherty *et al,* 2006; Kushler et al, 2006)[8].

A. Proposed Research in Renewable Energy Resources

-Solar Energy to Develop a Smart Energy Scenario to cut CO_2 emissions

Energy produced from renewable energy resources such as solar specifically for example, is stored in battery before consumption, which is a solar module, which will be able to supply energy uninterupted. The main advantage of the system is that energy production’s independence from electricity network. The proposed research is to investigate solar irradiance in a particular location and to build solar module at that location of maximum irradiance and to measure the solar energy produced and simultaneously send that estimated solar energy to a computer through wireless connection or cable. The system will be able to monitor specific types of investments that can be recommended for renewable energy resources are : (i) By expanded use of renewable energy resources for example Photovoltaics(PVs) for small-scale applications in high-insolation areas can reduce the Transmission & Distribution(T &D) losses of conventional energy resources; (ii) Use of PVs to provide supplementary power on grid-connected distribution systems, if the peak load matches solar insolation; (iii) To analysis the cost proposition for integrating distributed renewable –solar energy resources to the electricity grid (iv) Deploy a Service Value Network for Energy Service Companies(ESCOs) in the Smart-Grid infrastructure of Hybrid Energy Systems of integrated renewable energy recourses to the electricity grid.

Solar energy was conceived first at Moushuni Island case analysis. Later wind & bio-mass are considered to make the system hybrid renewable energy system.

IV. Grid-connectivity of Hybrid Renewable Power Plant

The proposition to connect the isolated remote hybrid renewable power plants to the conventional power grid is a challenge in the Indian scenario. West Bengal Renewable Development*s* Agency (WBREDA) in Eastern part of India is trying to electrify remote isolated villages through hybrid renewable energies. As a part of National Solar Mission of India, decentralized hybrid renewable energy plants are already operating in isolated Sagar Island and Moushuni Island of Sundarban of West Bengal-Eastern Part of India. Also decentralized Solar Energy for Village Electrification has been implemented in India. Grid extension for these isolated remote islands or villages can be the best option if the grid is reliable, the rural community rather big and in proximity to the grid.

This paper has focused on the integration of hybrid renewable energies resources into conventional electric grid and deployment of smart architecture of hybrid energy system in the user-centric pervasive computing concept [3],[4] in the context of Kyoto Protocol for sustainable development of the rural and urban sector[3], [4].

A concept of next generation mobile smart-grid city for efficient real-time collaborative use of renewable and non-renewable energy sources at smart user-centric device for sustainable green environment in the context of climate change is proposed for future research.

V. Proposed Research in Renewable Energy Resources to Develop a Smart Energy Scenario

Part 1: (d) Technology up-gradation: (i) Creation of a Standardized Interface and testing of that interface regarding hybrid energy system integration; Part 2: Development of Service-Oriented-Architecture (SOA)-Energy Portal (EP) for energy and utility integrating renewable energy sources with non-renewable energy sources in the present global scenario of creating a pollution free environment based on Kyoto Protocol for a sustainable development of any region.

VI. Role of Energy Service Companies

By feeding renewable electricity to the utility grid through grid-connected renewable energy system, during peak demand, sufficient electrical loads can be shed to prevent turning on a coal or natural gas-fired plant. Here comes the role of ESCOs (Energy Service Companies). This paper has illustrated on how ESCOs (Energy Service Companies), and ESCOs groups and ESCOs chains or e-energy service companies in the Smart-Grid network can optimize the national power shortage problem in peak demand period. It is a virtual service value network based on supply chain network of various energy trading companies. This proposition also helps to minimize the adverse challenges of climate change utilizing renewable energy resources at this service value network integrating into repository of conventional energy resources, thus reducing CO_2 emissions percentage and ultimately enhancing a green power scenario [5].

A service value network may be defined as "the flexible, dynamic delivery of a service, and / or product, by a business and its networked, coordinated value chains (supply chains and demand chains working in harmony); such, that a value-adding and target-specific service and/or product solution is effectively, and efficiently, delivered to the individual customers in a timely, physical or virtual manner."

The ESCOs helps to minimize the adverse challenges of climate change utilizing renewable energy resources at this service value network integrating into repository of conventional emery resources, thus reducing CO_2 emissions percentage and ultimately enhancing a green power scenario.

A. *Challenges Faced by Power Service Companies and ESCOs*

Environmental legislation in most industrialized countries calls for an increase in the production of renewable energy. The decentralized nature of facilities that produce green energy (solar energy), where **Green Energy or Sustainable Energy-**is the energy already passing through the environment as a current or flow, irrespective of there being a device to intercept and harness this power; compounded by natural fluctuations in power output, make it difficult for a power company to gather, validate, and deliver power-capacity data. Hence, estimation of reasonably accurate capacity forecasts is a greater challenge along with the changes in government policies that result in changes to subsidies and tax breaks granted to producers of green energy. Enterprise services into composite application of mainstream power business enable a power company to reliably gather green-energy data from disparate sources and to embrace change in the fast-moving green-energy part of its business. A power company needs timely information on its current and anticipated future capacities of green energy – a task that is extremely difficult to fulfil with error-prone manual and semiautomatic methods. Data sources typically include standard software solutions and a number of non-standard applications plus nonstandard databases run by the company's smaller suppliers of green energy. They may even include arrays of solar panels operated by individuals who merely have a separate electricity meter that relays data to the power company in real time. Collecting complex data from disparate sources such as these and then aggregating and validating all relevant data requires a tremendous amount of effort plus time-consuming communication. Also green energy is popular; a growing number of customers are prepared to pay a premium for "clean" power. To sharpen its competitive edge in a highly competitive and sometimes volatile market, a power company wants to deploy a solution designed to ensure the quality and currency of data; to automate the tasks of data gathering, aggregation, validation, and presentation; and to ensure sustained regulatory compliance [3]. Supply Chain Network of ESCOs should be integrated with the Network of energy trading Companies in Smart-Grid of hybrid energy system with the implications of treating energy trading companies as ESCOs.

VII. SOA-Energy Portal

A.SOA Basic Concepts

Service Oriented Architecture (SOA) is a business-centric IT architectural approach that supports integrating the business as linked, repeatable business tasks or services. SOA helps users build composite applications which draw upon functionality from multiple sources within and beyond the enterprise to support horizontal business processes. A composite application is a set of related and integrated services that support a business process built on SOA. As a gross generalization, a service is a repeatable task within a business process. Identification of business processes and then identification of set of tasks within that each process. Next tasks are defined as services and the business process is a composite of services. Service orientation is a way of integrating the business as a set of linked services. A Service Oriented Architecture, then, is an architectural style for creating an enterprise IT architecture that exploits the principles of service orientation to achieve a tighter relationship between the business and the information systems that support the business. Finally, SOA-based enterprise architecture will yield composite applications. A Service Oriented Architecture (SOA) is set of principles that define an architecture that is loosely coupled and comprised of service providers and service consumers that interact according to a negotiated contract or interface. These services provide the interfaces to Applications in the IT landscape. The primary goal of SOA is to expose application functions in a standardized way so that they can be leveraged across multiple projects. This approach greatly reduces the time, effort and cost it takes to maintain and expand solutions to meet business needs [6].

A Service-Oriented-Architecture (SOA) can be deployed for the proposed Hybrid Renewable Energy Systems integrating to the Eastern Regional Grid of India, considering isolated Sundarban Islands[3],[4],[6].

B. Business Problems Addressed by SOA

A large organization typically has many relationships with external business entities such as business partner and suppliers. These relationships are fluid in nature and frequently change for which a new approach is required to meet these fast-changing business conditions to provide flexible, agile IT systems that could meet theses fast-changing business needs of the time. SOA answer the problem with an emphasis on agile IT system through the use of reusable components. In this architecture, computer programs or components developed instead of solving a specific business problem provide some generic functionality, where theses component can be threaded, linked, or integrated in a specific order or configuration to meet a specific business need. If the business requirement changes, there is no need to develop a new computer program and the system can be reconfigured to meet the new business requirement. Generally, the different kinds of technological heterogeneity exist in a large enterprise, which are as following: *(i) Middleware heterogeneity:* Generally in a large enterprise, more than one type of middleware is being used and two most common types of them are application servers and message-oriented middleware (MOM);*(ii) Protocol heterogeneity:* This heterogeneity refers to the different transport protocols being used to access the services offered by various applications; *(iii) Synchrony heterogeneity:* There is always a need to support both synchronous and asynchronous interactions between applications, which leads to a situation where the types of interaction supported by the two applications that wish to interact do not match; *(iv) Diversity of data formats:* Most of the time the data is dependent on the middleware being used , also can cause a problem if two applications that wish to interact support different data formats; Diversity of interface declarations: There are large difference in the way the service interfaces are declared and used to invoke a service; No common place for service lookup: Sometime there are no common place to look up services to deal with the diversity of services in a large enterprise.

VIII. ROLE OF ENTERPRISE SERVICE BUS (ESB) IN SOA CONFIGURATION

ESB provides a comprehensive, scalable way to connect a large number of applications without the need for each pair of applications to make a direct connection. Such a direct connection between two applications is called a *point-to-point connection.* In Web Services, the connection between the service consumer application and the service provider application is "point to point". The point-to-point connection approach does not scale well because the number of applications involved in the integration increase; therefore, this integration approach is not suitable for a large enterprise where a large number of applications need to be integrated. The fatures of ESB are as: (i) An enterprise service bus (ESB) is the infrastructure of SOA; (ii) Its purpose is to provide interoperability (connectivity, data mapping, and routing) combined with some additional services such as security, monitoring, and so on; (iii) An ESB can be heterogeneous. Basic Services are services that each provide a basic business functionality, which provide the first fundamental business layer for one specific backend or problem domain. The role of these services is to wrap a backend or problem domain so that consumers (and high-level services) can access the backend by using the common SOA infrastructure. Hence, by introducing basic services, we get the fundamental SOA. With basic services introduced, service consumers can use an ESB to process the business functionality that one back end is responsible.

IX. .SOA-ENERGY PORTAL (EP)

Creating a SOA-Energy Portal(EP) onto a Smart Device for power generation, transmission and distribution companies and Energy Service Companies (ESCOs) will help to reference real-time data related to power generation, transmission and distribution and peak load scenario of different utility consumers from diverse sources; for which SOA-EP features a unification server. This unification server includes a collaboration component, supporting real-time collaboration among various ESCOs and power plants at different sites via virtual rooms and different collaboration tools. Also the supply chain capabilities of individual supply chain members of various renewable and non-renewable energy sources are brought together through mapping of Supply Chain Configuration Framework for renewable and non-renewable Energy sources to enable joint decision making and technological implementation of decisions. Cross-enterprise functionality of State Grid with the remote renewable energy sites and non-renewable energy sites has to be efficiently shared information cross all the departments and power generation plants and transmission and distribution network and also to work seamlessly with ESCOs and suppliers and communicate easily with industrial and domestic energy customers. This state grid can interact with entities outside it i.e. can integrate with renewable and non-renewable energy sources i.e. entities outside the boundaries of state grid and interaction has to be done to complete and succeed globally.

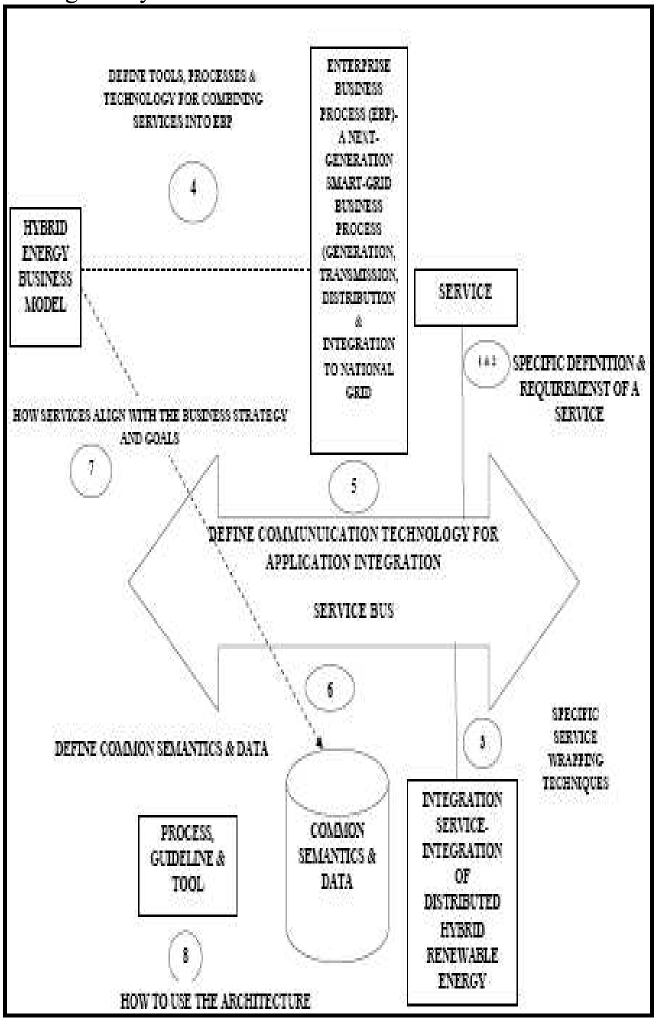

Fig.1. A Next-Generation Smart-Grid Perspective of SOA [4]

Source: Adopted from Applied SOA: Service-Oriented Architecture and Design Strategies by Michael Rosen, Boris Lublinsky , Kevin T. Smith , Marc J. Balcer

SOA is a design for linking business and computational resources (principally organizations, applications and data) on demand to achieve the desired results for service consumers (which can be end users or other services)[1],[2],[6]. Fig. 1 depicts a Next-Generation-Smart-Grid perspective of SOA[6] and the numbered circles in this figure correspond to the numbered list as: (1) A definition of services, the granularity, and types of services; (2) How services are constructed and used; (3) How existing packaged and legacy systems are integrated into the service environment; (4) How services are combined into processes; (5) How services communicate at a technical level (i.e., how they connect to each other and pass information); (6) How services interoperate at a semantic level(i.e., how they share common meanings for that information);(7)How services align with the business strategy and goals; (8) How to use architecture ?

Fig 2. is a proposed topology for deployment of SOA through ESB in Hybrid Energy Systems

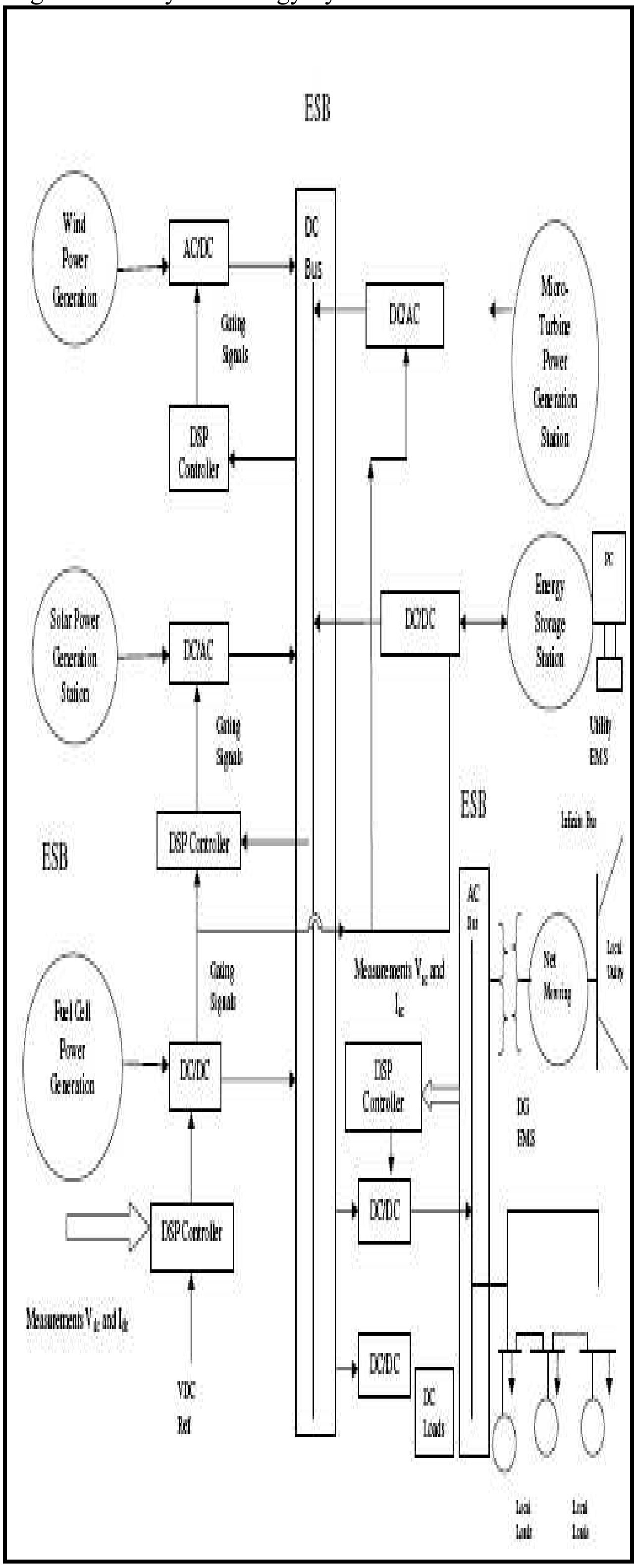

Fig.2. Deployment of SOA through ESB in Hybrid Energy Systems

X. Case Analysis

XI. Case Analysis of Moushuni for SPV-Wind-Bio Hybrid Renewable Power Plant

WBREDA has set up a 53.5 kWp Solar PV Power Plant with an integrated daytime water supply system at village Bagdanga of Moushuni Island. Total population of this island is about 20,000. Primarily 300 families will be benefited with this Power Plant. Moushuni Island is a small picturesque island situated near Sagar Island and between Muriganga and Chinai rivers but very close to Bay of Bengal. *(A 20 kW Biomass Gasifier System is recommended to give back-up to this Hybrid Renewables System for a reliable electric supply during shortage of intermittent renewable like solar, wind)*

WBREDA in Eastern part of India is trying to electrify remote isolated islands through hybrid renewable energies. The proposition is to optimize that hybrid renewable energy plants of remote islands so that it can be grid-connected to feed the extra renewable after optimized use at those islands and vice versa. The aim is to design, develop and successfully deploy a modular solution for an existing renewable power plant operated by WBREDA, located at Moshuni Island, in Sundarbans of West Bengal, India.

Objective of the Project: Objective of the Project is (i) To Install Grid Interactive Operation of Hybrid Solar Photovoltaic (SPV), wind, bio-mass System at Moushuni Island;(ii) To ensure the reliability and efficiency of the system to optimize the utilization of the hybrid renewable energy sources; (iii) To design, fabricate and deply reliable power electronic fron-end interface with modular hardware; (iv)This modular hardware is made indigenously for converting power output from multiple small-scale renewable energy sources and storage elements into usuable voltage and frequency levels.

Problems: (i) The existing components in the existing system in Moushuni Islands for tapping sources like solar, biomass, wind etc. are not uniformly designed for integrated operation; (ii) Issues of maintenance, service and spares tend to reduce availibility of theses power plants.

Fig. 3 is illustration for the Assembled and Tested units proposed to be installed at Moushuni Island to control the solar-wind hybrid power plant for optimized use of renewable energy resources generated in the plant throughout the year to be grid-connected if required.

Solutions: All interfaces need to be on a common AC link, which also serves as the feeder to the loads. A universal interface for hybrid renewable energy sources with technology for integrated operation is required.

Technical Features : These features are as follows (i) Maximum Power Point Tracking for wind electric generator(WEG) systems; (ii) MPPT for solar PV panels; (iii) Parallel operation of load side inverters; (iv) Parallel operation of battery chargers.

Input Side Features: The universal 10kW power electronic Basic Interface Module (BIM) with capability to interface with solar panels (variable current, DC), battery bank (fixed voltage, variable current, DC), wind generators (variable frequency, variable voltage AC), AC generator working from bio-mass(variable frequency, variable voltage AC) on the input side.

Output Side Features: The fixed frequency, fixed voltage AC link on the output side.

Control Algorithm: The control algorithm will ensure integrated operation of all the interface modules connected in parallel so as to feed a 20 kW load (Max.), to the feeder. Specific modules will be programmed with suitable control algorithms, which can be used to extract maximum power from a SPV source or WEG. A central controller is proposed to ensure the integrated operation f the power system and to realize user interface. (See Fig. 3).

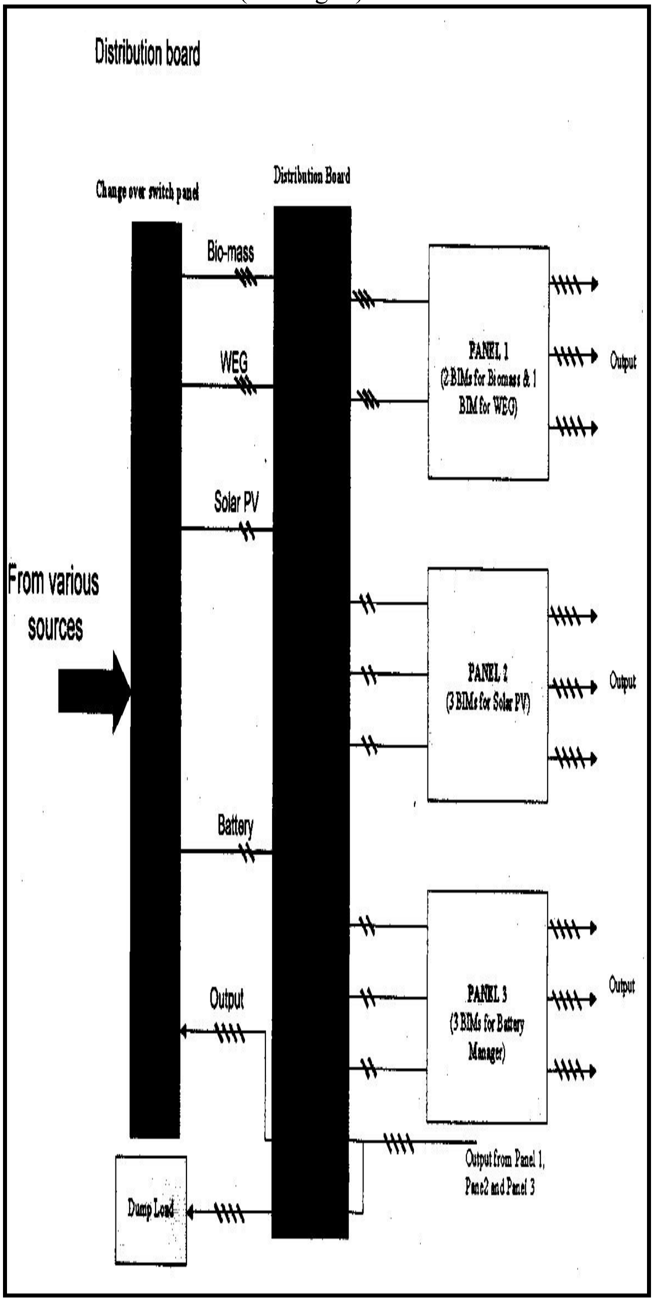

Fig.3. Intelligent Controller for Optimized use of Hybrid Renewable Energy Resources Tested at WBREDA for Installing at Moushuni Island [7]

XII. Block Diagram for BIM, Digital Controller Proposed to be Installed at Moushuni Island

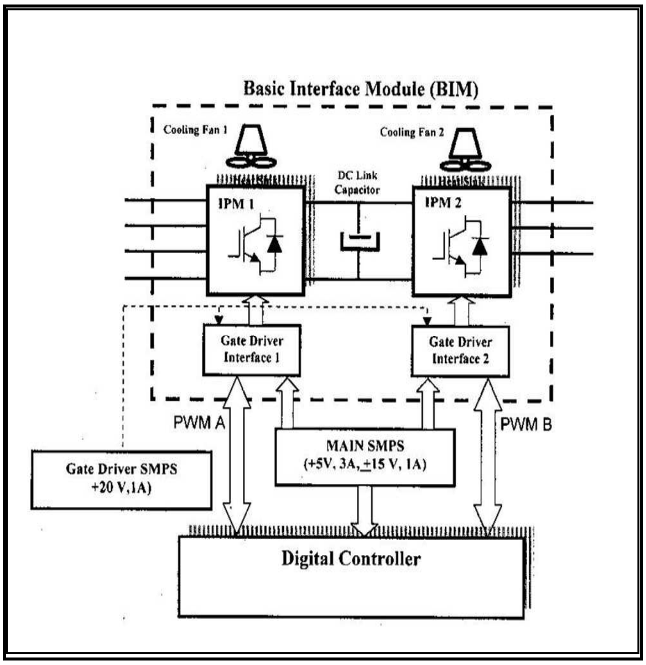

Fig.4. Scheme of BIM and Digital Controller for Grid-Connected System at Moushuni Islands [7]

Basic Interface Module (BIM): BIM is a back-to-back, three limb, two-level Voltage Source Inverter (VSI) topology sharing a common DC bus. This basic module can be customized through controls to fit the interfacing requirements of the known sources of renewable energy (See Fig. 4 & 5).

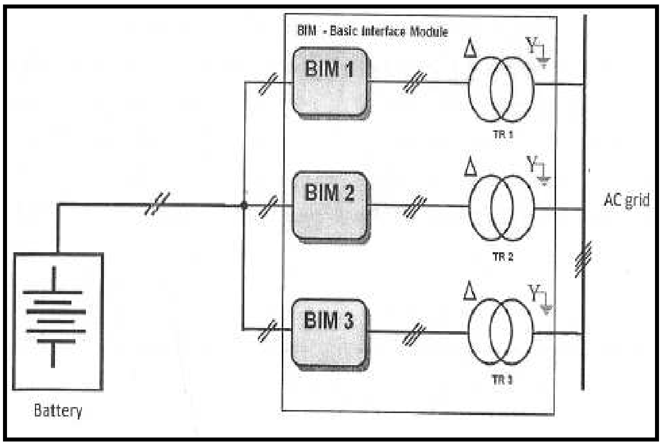

Fig. 5. BIM [7]

XIII. The State of the Art Analysis of Hybrid Renewable Power Plant While Grid –Connected in Smart Energy Scenario

Table I illustrates the state of the art analysis for the hybrid renewable system at Moushuni Island & the beyond state of the art analysis for this renewable energy system, when it will be grid-connected in the smart-energy scenario.

TABLE I
Advantages of Beyond State-of-the-Art for the Hybrid Renewable Energy System Integration into the National Grid

Hybrid Renewable Energy System	
State of the Art	**Beyond State of the Art**
Most Intelligent Controller at Moushuni Island to Optimize Solar-Wind-Bio-mass Hybrid Renewable Energy Resources	Smart-Energy Scenario by integration of Hybrid Renewable Power Plant to the National Grid
Minimization of fossil fuel consumption	During time of peak demand, sufficient electrical loads can be shed to prevent turning on conventional power plants and therefore save CO2 emissions and potentially energy import costs, replacing fossil fuels.
Diesel Consumption decrease by increase of solar & wind penetration at Moushuni Island	Deployment of SOA for Hybrid Renewable Power Plant to control smart decision support system from a single entry point by the ESCOs in a Smart-Grid Scenario-the combination of renewable & conventional resources to tackle power shortage in peak demand on

XIV. Conclusions

A smart-energy market where an integrated hybrid renewable energy system into the smart-grid –a service oriented architecture can be designed to assess market potential of conventional versus renewable via acceptance index(AI)[2], [3], [4], [5] which is accessible to a mobile device or any smart device into a single entry point to the utility customer for efficient reliable use of energy resources in the context of environmental pollution control scenarios reducing Grren House Gas(GHG) in the context of Kyoto Protocol for rural and urban sustainable development.

In addition, 'Hybrid systems' also have enormous potential for remote areas. Wind turbines, possibly with additional solar resources, are used in conjunction with back-up diesel generators, which operate as required. The renewable sources typically supply 60-85 % of energy. Existing renewable energy systems and DG sets are not adequate to fulfill the actual demand of electricity at Sagar Island. Hence, more Solar Photovoltaic (SPV) and wind energy is required to be installed and which would be Grid-Conned via Eastern Regional Grid to form an unified Smart-Grid System, through which extra renewable energy after fulfilling the consumers demand of Moushuni Island will be exported to the conventional National Grid and vice versa when there will be shortage of hybrid renewable energy sources to satisfy the needs of the customers of Sagar Island. Also intermittent supply of SPV and wind energy and other renewable sources should be fully utilized .

Deployment of Service-Oriented-Architecture(SOA) will be based on the topology of this Hybrid Renewable Energy Systems and also Grid-Interactive Solar Energy System or Solar-Wind integrated System, which may be distributed but can be mapped for feeding into the National Electricity Grid through proper deployment of SOA.

A smart-energy market where an integrated hybrid energy system of renewables and conventional resources together, with the services of Energy Service Companies(ESCOs) can have impact to reduce CO_2 in the by replacing conventional with renewable. A Smart-Grid scenario of integrated renewable energy system into the conventional electricity grid can be proposed and in this scenario, service value network of ESCOs in the Super Smart-Grid of Hybrid Energy System enabled with energy efficiency and energy conservation (ENCON) measures can optimize the demand for power in peak demand period to tackle the power failure synchronizing with the suitable location of insolation in case of electricity driven by solar energy resources as for example .A cost proposition of renewable energy resources can have impact to substitute conventional energy resources in the peak load scenario also thereby reducing T & D losses of conventional system ultimately. Supply Chain Network of ESCOs facing challenges which can be resolved by with the design and testing of common Grid standardized Interface for integrated operations of tapping solar, bio, and wind energy resources. Renewables can be coupled with energy efficiency measures along with strong environmental measures to go hand-in – hand with economic and social benefits.

By feeding renewable electricity to the utility grid through grid-connected hybrid renewable energy system, during time of peak demand, sufficient electrical loads can be shed to prevent turning on conventional power plants and therefore save CO2 emissions and potentially energy import costs, replacing fossil fuels.

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