Internet of Things (IoT) Based Solar Renewable Energy Intelligent Irrigation System with Robot

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***Abstract*—Climate change and the finite nature of traditional electricity production sources have resulted in the increasing utilization of renewable electricity sources in today's electricity grid architecture. Which is hoped to eventually lead to a hundred percent renewable electricity grid architecture. A purely renewable electricity grid will bring about the implementation of the Internet of Renewable Energy (IoRE). The European Union (EU) in an attempt to stimulate and strengthen the integration of electricity grid architecture of member states has set in motion several strategies. A great strategy should be a purely renewable electricity grid assets integration in the region. Besides hydro and wind energy, bioenergy is following on the listing of vital renewable energy sources consumed in the European electricity generation mix. Bioenergy electricity combined with other renewables on the IoRE framework will lead to a sustainable electricity grid integration in the EU. The anticipated utilization of IoRE technology in the short-term and long-term in the region will lead the way to assess a hundred percent renewable electricity product by consumers in each member country. It will as well bring about cleaner electricity product production in the EU.**

Keywords—bioenergy, bioenergy electricity, Internet of Renewable Energy (IoRE), sustainable regional electricity, European Union (EU)

I. INTRODUCTION

The main issues that are being faced all over the globe today are energy security, sustainability, pollution and impacts of climate change [1] - [3]. Some school of thought has a view of permanently adopting to a hundred percent renewable economy to successfully bring about a conclusive and a permanent solution to these issues [1]. The choice of a purely renewable electricity structure is in the advancement of renewable technologies. Renewable technologies are undergoing fast-track evolution and have the capacity of a zero-carbon footprint. The zero-carbon latent qualities of renewables make them uniquely suitable in this circumstance to tackle climate change. Since climate change is presumably the most crucial issue the world is facing today [4]. A purely renewable electricity grid architecture is presented in Fig. 1.

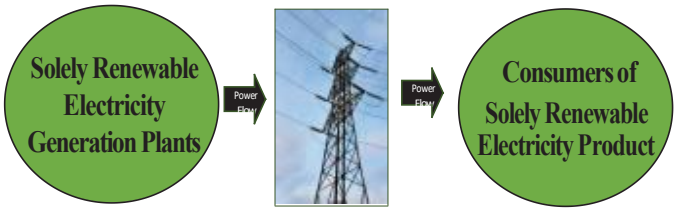

Fig. 1. A purely renewable electricity grid architecture.

A completely aligned renewable electricity structure will only utilize renewable electricity generation resources. Which will eventually give rise to an Internet of Renewable Energy (IoRE) framework. IoRE is an invention by Famous Oghomwen Igbinovia, for the intelligent utilization and monitoring of a purely renewable electricity grid architecture [5] - [8].

An important renewable resource that can be used to produce clean electricity is bioenergy. The organic substance that is practically used for producing bioenergy is biomass. Considering the source and the process of forming bioenergy. It is linked to energy obtained from the sun, produced by way of photosynthesis. This makes bioenergy one of the main renewables available for generating clean electricity. Biomass is normally thought of as nature's solar batteries, in which chemical energy is converted into electricity for use as a source of power. This is so said since it is a storage house for bioenergy [9]. Bioenergy electricity production is hoped to be on the rise in the future. Affirmative policy and market progression in established and emerging economies suggest an encouraging futuristic prospect for bioenergy electricity product [10].

The adaptation of EU member states to a biobased economy is anticipated to lessen reliance on finite resources and successfully bring about a more sustainable economy. Hence, instrumental to climate and environmental preservation. The EU governments are working acidulously with the aim of establishing a bioeconomy. This will necessitate disintegrating plants into their constituent parts as totally as feasible and changing them into extremely useful substances to generate electricity. It is anticipated that this problem will be taken care of in the future by large biorefineries with several synchronize

series of steps to achieve the desired end [11]. It is necessary for EU to make the transition to a total renewable electricity asset, as it has the might to do so. This should include a fair share of bioenergy electricity. A hundred percent renewable resource base electricity grid infrastructure is no longer just an option, it is a necessity, as it will help to solve issues related to climate change and other related issues in the region.

The rest of the paper is organized as follows: Section II describes the motivation for this research. Section III discusses European Union bioeconomy, global and EU's bioenergy electricity transition. Section IV talks on electricity as a component of bioenergy. Section V discusses Internet of Renewable Energy (IoRE) platform for sustainable bioenergy electricity integration in the EU. Finally, Section VI concludes the paper.

II. MOTIVATION FOR THIS RESEARCH

The world at large is now in an age of intelligent electricity product administration. It is as well a time that the electricity industry is apprehensive about the impacts of climate change. Therefore, it is of great significance to continue to learn and invent ways to intelligently and sustainably operate the electricity grid architecture. Particularly with emphasis on the purely renewable electricity grid. This is anticipated to make a marked change in the generation, transmission, distribution and the eventual usage of purely renewable electricity product. IoRE will ensure that the constituent of a purely renewable grid, with a fair share of bioenergy electricity function together in an intelligent manner.

Bioenergy is an exceptionally pliable renewable electricity source. It can at a fast speed be skilfully managed to meet the demand of electricity consumers. For this reason, it constitutes an appreciable support for weather-reliant renewable electricity generating plants like wind and solar.

Burning organic matter used as a fuel in power station for the generation of electricity, releases carbon dioxide to the atmosphere. But it releases the same quantity of carbon that the organic matter used to produce the fuel and absorbed while it grew. Hence, it does not break the carbon balance of the atmosphere. This helps in attaining a net zero carbon dioxide discharge by balancing carbon discharge through the removal of carbon most frequently achieved by way of carbon offsetting. It can equally be achieved by directly getting rid of the net carbon discharges. This is known as carbon neutrality.

III. EUROPEAN UNION BIOECONOMY, GLOBAL AND EU'S BIOENERGY ELECTRICITY TRANSITION

Bioeconomy is considered as the making, effective usage and preservation of biological materials. This is including of biology associated knowledge, science, technology, and innovation, to make available for user information, products, processes, and services covering all economic spheres with the intention of achieving a sustainable economy [12]. Bioeconomy is the EU's reaction to major environmental issues facing the human race. It is intended to minimize the reliance on nature's resource, change industrial production, further the progress of sustainable manufacturing of renewable sources from land, fisheries/aquaculture and their transformation into food, feed, fiber, bio-based products, and bioenergy. While at the same time creating fresh jobs and businesses [13]. The EU bioeconomy put together forms a valuable section of the region's entire economy. It takes into employment millions of people and generates approximately trillions of Euro. This suggesting that bioeconomy constitutes a considerable share of all sectors of EU's economy with respect to employment, as well as money generated by businesses in the region [14]. Thus, the European bioeconomy proffer a future window of opportunity to harmonize economic development with environmentally trustworthy measures [15].

The process of changing to a sustainable bio-based economy infers that the conventionally made arrangement and manners of living that is seen as usual nowadays necessitate to be totally re-examined. For this reason, it is of the essence to position investigations on a wide premise. This is to get correct answers to apparent civic problems and progressively incorporate branches of knowledge like social, economic, cultural and humanities. This is a necessary condition to confront the issues opposing us as civic problems and to understand clearly technological innovations as a constituent of civic composition and humankind's existence [15]. In the International Energy Agency (IEA) recent report, it posited that global bioenergy electricity generation for the year 2000 through the year 2030, is envisaged to become greater in amount. Extract from this report as seen in Fig. 2 shows that in the year 2000, global bioenergy electricity generation was 132 Terawatt hour (TWh). In 2010 it was put at 310 TWh. The year 2020 expected value is estimated at 640 TWh. While for the year 2030 the anticipated estimated value is 1168 TWh [10]. IEA is an independent intergovernmental institution recognized in the composition of the Organization for Economic Cooperation and Development (OECD). Its headquarters is situated in Paris, France.

Governments proposed action and trade progressions gives a practical explanation of the firm utilization of bioenergy for electricity provision. Countries are laying down new criteria's that is anticipated to multiply the practical use of biomass plants for the generation of electricity. With a focus on regions owning a very high volume of biomass resources for clean electricity generation [10].

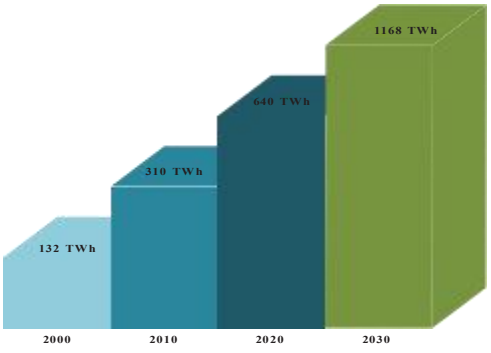

Fig. 2. Global bioenergy electricity generation from 2000 – 2030.

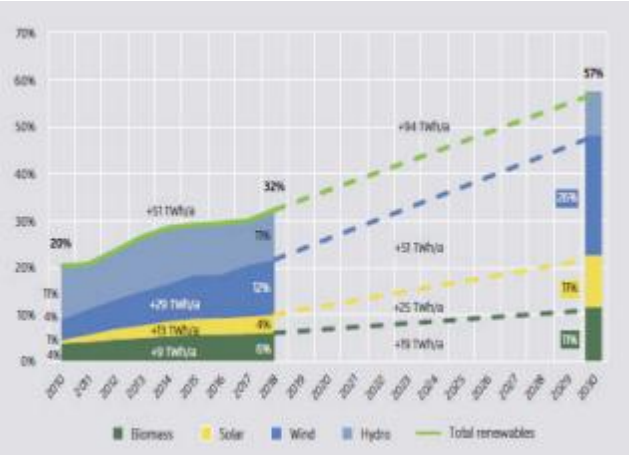

Fig. 3. European commission's long-term renewable electricity Strategy, with a fair share of bioenergy electricity [16].

In the European Union, the comprehensive share of renewables is anticipated to rise from thirty percent in 2015 to fifty-seven percent in the year 2030 as presented in Fig. 3 [16]. The share of wind and solar renewables is expectedly to triple from twelve percent in 2015 to thirty-seven percent in the year 2030. On-land and off-land wind plants is expected to continue to exist as the most domineering renewable plants. They are positioned to turn out to be the abundant single origin of renewable electricity by the year 2030. By that time, wind plants will amount to twenty-six percent of all the whole renewable electricity generation. Renewable electricity harvesting from hydro plants will continue to be steady. Bioenergy electricity generation will rise by approximately fifty percent. Wind and solar plants altogether will reckon for fifty-three percent of the net overall installed renewable plants output by the year 2030. This will be to some extent, owing to the necessity to increase the number of supplementary renewable plants. Which will help to meet any increase in electricity consumption in other sectors of the EU economy with negligible carbon electricity provision [16]. Even so, the European Commission as well have in prospect a remarkable growth in bioenergy electricity utilization after the year 2030. Thereby causing consequential sustainability worries. Europe's renewable electricity industry needs to successfully reach far appreciative standing of renewable plants integration. This can be in the stretch of eighty-one to eighty-five percent by the year 2050 [16] – [17].

IV. Electricity as a Component of Bioenergy

Bioenergy is to an extent essentially consequential for electricity security in respect of renewable electricity generation. It is a means of solving the issue of exhausting fossil fuels. Bioenergy such as heat, electricity, and biofuel is produced by conversion machines making use of biomass like home-produced debris, root crops, forest remnant, and animal mud. The principal constituents of bioenergy are displayed in Fig. 4. Anaerobic digestion, combined heat and power machine, and pyrolysis are among the conversion machines of bioenergy. Base on the nature of biomass, it can be processed with diverse machines to produce certain products. These products when further treated with more machines, is changed into end products i.e. bioenergy [18].

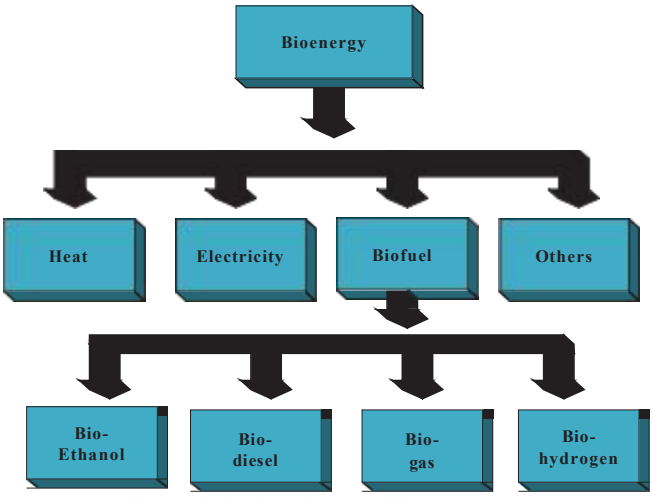

Fig. 4. Principal constituents of bioenergy.

Among diverse kinds of renewable resources that are at the present time used on the planet. The portion of bioenergy utilized for human needs is leading as compared to other renewables. Bioenergy at the moment meets about ten percent of the planet's requirement for principal energy. It is in most occasion entirely use to prepare food and provide heat in buildings in poor nations [19]. But in spite of that, a number of researches have forecast noteworthy expansion in the contemporary bioenergy sector in the future. This is owing to a robust policy on the part of governments in both poor and advanced nations [20]. Other influencing factors for expansion in the contemporary bioenergy sector is evident in massive request and growing widespread perception connected with robust bioenergy blueprint. Which will drastically lessen carbon dioxide (CO_2) discharges, augment renewable electricity security and play a part in sustainable electricity initiative [21].

The procedural trackway of biomass, machinery utilized, intermediate products and bioenergy in an embarked form change procedure is known as bioenergy pathway. A changing pathway is a course through which a biomass material is transformed into bioenergy; it includes the utilization of a variety of equipment and harvesting of different sorts of intermediate products. It makes it easier for farmers to see the ability of a bioenergy plant to work successfully in a locality. This relying on the category of biomass obtainable in a region. Depending on the inherent characteristics of biomass, it can be processed with novel equipment in diverse pathways. There are alternative pathways that can, either way, begin from anaerobic digestion or intermediate pyrolysis [22]. Anaerobic digestion is a practical procedure of processing biomass with anaerobic bacteria in a condition that is lacking oxygen. In this manner, giving rise to biogas and digestate. The biogas is used mostly in Combined Heat and Power machine (CHP) to create heat and electricity. In contrast, the digestate can be processed as fertilizer for agricultural purposes or dried and processed with intermediate pyrolysis. Intermediate pyrolysis is a practical technique of heating biomass at a high atmospheric condition, in a closed cylinder. It gives rise to intermediate pyrolysis gas, intermediate pyrolysis oil, and bio-char. The intermediate pyrolysis gas is attended to with combined heat and electricity machines to bring about heat and electricity.

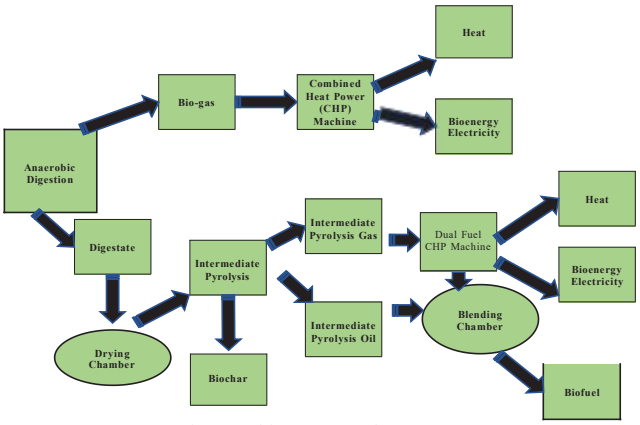

Fig. 5. A bioenergy pathway.

In comparison, intermediate pyrolysis oil mixed with biofuel results in two choices. Either selling it as it is or processing it with Dual Fuel CHP machine (dCHP) to yield heat and electricity. The bio-char is disposed of to get some earnings. As well, there are variance in the techniques. The biogas, that is the intermediate pyrolysis gas is then attended to with a generator. This generates only electricity, without any heat. If the digestate cannot be sold, it is dried and moved into the intermediate pyrolysis path. Which yields other intermediaries and final products in the intermediate pyrolysis scheme. Fig. 5 portrays a biomass conversion pathway. It begins with anaerobic digestion. The digestate is then dried and moved into the pathway. That now begins with intermediate pyrolysis. The pathway intermediaries like intermediate pyrolysis gas and the mixed intermediate pyrolysis oil is at this time moved into the dCHP to create heat and electricity [23].

V. IoRE Platform for Sustainable Bioenergy Electricity Integration in the EU

The EU has laid a decarbonization responsibility target for its member states. Distinct means of pursuing this target, like well-organized renewable electricity obligatory targets and CO_2 discharge levy, are encouraged and carried through in the region. The electricity sector can be specifically saddled with the responsibility of making sure that the transition program works out. The growing participation of renewables in electricity production, choice of island renewable electricity solution and so on, gave rise to newly discovered issues pertaining to the design and functioning of the European integrated electricity grid architecture [23]. It is of interest to note that after hydro and wind, bioenergy is next on the listing of very important renewable sources in the European renewable electricity generation mix [24].

When biomass is deployed as a power source, it is described as feedstock. Feedstocks are cultivated precisely for their power quality constituent, take for instance energy crop. They are an embodiment of unusable by-products from agricultural, food and timber processing activities, etc. Dried out incendiary feedstocks like compressed rounded little pieces of wood are burnt in either boilers or furnaces. This then boils water and give rise to steam for propelling a machine (turbine) for producing electricity. Moistened feedstocks like food leftovers are placed in securely fastened storage chambers where they become rotten to yield methane gas, which is biogas. This gas is trapped and burnt to produce electricity. It can as well be put to use in the kitchen at homes for preparing food and heating of buildings. Bioenergy is an extremely adaptable renewable resource. It can be swiftly maneuvered to meet electricity needs. Thereby having a great capability for backing intermittently available renewables like wind and solar technologies [25]. When biomass is burnt CO_2 is discharged. Since it discharges the same quantity of carbon the organic substance used to produce it and absorbed in its growing process. It does not break the carbon balance of the envelope of gases surrounding planet earth. In contrast to the burning of fossil materials such as coal, gas, and oil that releases CO_2 locked away for a very long period of time. Even from the period that the gases surrounding the planet were distinct. This increases the amount of CO_2 present in today's atmosphere. Thereby breaking the earth's carbon balance. The comprehensive sustainable and environmental strong points of bioenergy is based on the feedstocks used, namely waste or energy crops.

The Internet of Renewable Energy system in the context of a fair share of bioenergy electricity in the EU region will consist of numerous distinct renewable electricity generating schemes working together. Such as an electrical island renewable scheme. With a fair share of small bioenergy electricity plants for distributed electricity generation. This is expected to support essential electricity product demand by consumers. While a grid-connected renewable electricity scheme, with a considerable share of large bioenergy electricity plants, will feed electricity product to both essential and non-essential electricity demand. It will function as an electrical island grid architecture under grid failure. The rregions purely renewable electricity monitoring will be essentially realized by principally using IoRE intelligent automation technology. This intelligent clean energy monitoring technique is an innovative solution that will be used to define purely renewable power system codes. IoRE will facilitate bioenergy electricity integrated purely renewable electricity market model implementation in the EU. This becomes even more important since other power system networks not in the EU region can as well be tied to it. To be sure that all the connected regions are getting information, IoRE will be deployed. Moreover, purely renewable electricity monitoring in the European Region using IoRE can contribute to the balancing, reliability and improved efficiency of the supply of purely renewable electricity product to end-users in the region [26]. Fig. 6 depicts an IoRE framework in a purely renewable electricity grid architecture, having a reasonable share of bioelectricity for a purely clean electricity supply.

EU's climate change and energy blueprint goals necessitate a substantial amendment of its electricity structure. The European electricity grid architecture is of considerable size and very complicated. It is going through technological, social and regulatory changes [27]. A fundamental modification should be a huge introduction and utilization of only renewable electricity generators, having a sizeable allocation of bioenergy electricity generators. This will initiate or pave the way for purely renewable grid architectures in the region. Internet of Renewable Energy technology and sensor constituents will be used for intelligent coordination of the grid. This will

absolutely change the structure and operation of the grid. Since only renewables will be absorbed in this future grid. Thus, new standards will be required. The European Commission is furthering the progress of several blueprints with a view at novel directions of the future grid. This is being done by authorizing the appraisal of relevant standards and championing clearly defined research and development projects. But there is more to be done in order to achieve a hundred percent clean and eco-friendly environment. Therefore, it is high time for the European Commission to pay more attention towards research having relevance to purely renewable electricity grid architecture. More so, when it is associated with bioenergy electricity generation technologies. Achieving this will make the Internet of Renewable Energy practicable.

An essential supporting proposed action for a flexible future electricity grid architecture by the European Commission should be pointed at providing only clean, environmentally friendly, stable, sustainable, competitive and inexpensive electricity products to EU's citizenry. This conceptualization should allow for a unified inter-continental and continental-wide purely renewable electricity grid system. Where only clean renewable electricity products will flow without constraint beyond borderlines, rooted in competition. With the potential usage of obtainable renewable electricity resources in the region. Here, prominence should be on both large and small bioenergy electricity generators. Therefore, modification of the present time electricity power system to a purely renewable electricity grid architecture is eminent. Automation of the future solely renewable grid with IoRE is paramount. This will promote sustainability, raise the competence, and guarantee of a clean electricity product generating grid. It will as well help to accomplish a domestic purely renewable electricity market intention. The practical execution blueprint for a solely renewable electricity grid on Internet of the Renewable Energy (IoRE) domain will necessitate a sound supervisory and standardization endeavor. Much emphasis should be put on bioenergy electricity generating plants owing to its potential in the region. Internet of Renewable Energy technologies and services will be extremely important in harvesting the opportunities able to be obtained in the future purely renewable grid architecture and market. It will necessitate authorizing solely renewable electricity product consumers and prosumers to take control of their completely renewable electricity product consumption and self-generation.

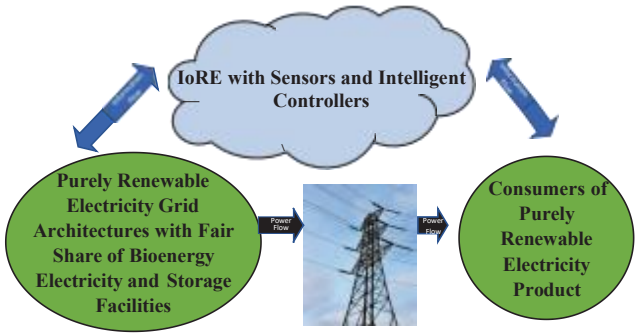

Fig. 6. IoRE framework implementation in a bioenergy electricity integrated purely renewable electricity grid architecture.

VI. CONCLUSION

Global warming occurring from large-scale CO_2 production and discharge is of growing worry in the EU. It causes unpleasant environmental impacts. Hence, the need to decarbonize the regions ecosystem. A tough and sustainable solely renewable electricity grid architecture should be the essential point of the European Union's future electricity product campaign plan. This paper utilizes the distinction of a hundred percent renewable electricity grid infrastructure on an Internet of Renewable Energy (IoRE) framework for the integration of EUs electricity grid system. To this end, bioenergy electricity generation in the EU should be given priority, owing to its place in the region after hydro and wind renewable electricity generation.

Purely renewable electricity integration with a fair share of bioenergy electricity within the European Union will be able to meet resident's electricity product consumption. The general consequence on each member state will be to a very great degree beneficial. Therefore, national bioenergy electricity integration goal should be cautiously laid down for member states. This will multiply the overall bioenergy electricity generation plants integration and consumption in the EU. Notwithstanding, single member states bioenergy electricity short-term and long-term goals should be put into consideration. This methodology will not only expedite in combating the impact of climate change issues in the region. It will on the long-run help in the inter-continental and continental-wide purely renewable electricity grid integration.

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