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An Overview On Bioenergy: Current Trends, Challenges And Scope In India

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Abstract: The requirement of energy for human being in the planet earth is increasing day by day. The major source of energy is based on fossil fuel only. Thus, the scarcity of fossil fuels, rising price of petroleum based fuel, energy protection and increased global warming resulted in focusing on renewable energy sources such as solar, wind, tidal and biomass worldwide. Bioenergy is one of many diverse resources available to help meet our demand for energy. It is a form of renewable energy that is derived from recently living organic materials known as biomass, which can be used to produce transportation fuels, heat, electricity, and products. The major forms of bio energy is biopower or electricity generated by the combustion of biomass, biogas produced by anaerobic fermentation of different forms of organic matter and biofuels (biothenol, biodiesel, etc). The feed stock sources used for the production of bioenergy are the forest based, agriculture based and municipal waste based. There are three Technologies used for the conversion of feed stock into bio energy i.e.thermal, chemical and biochemical processes. In the recent years, India has become a pioneer in climate protection and is one of the few countries to have performed exceptionally on the mitigation goal of NDCs. In order to promote bio energy in the country a national policy on bio energy was made by Ministry of new and renewable energy during the year 2009 and also its amendment in 2018. It was supposed that India will bring its non fossil base energy capacity to 500 GW by 2030 and full fill 50% of energy requirement through renewable energy, and roduce carbon intensity of its economy by more than 45%. The aim of the policy are to reduce import dependency, cleaner environment, MSW management, employment generation, infrastructural investment in rural areas and additional income to the farmers. In this paper bioenergy and its forms, conversion technology, social, economic, ecological, and environmental impacts of bioenergy, and challenges in sustainable bioenergy production are discussed. Various bioenergy policies and programs introduced to accelerate bioenergy in India in past years are emphasized in the paper.

Keywords: Bioenergy, biopower, biofuel, national policy on bioenergy, environmental impact.

Introduction: We all know that organic matter such as wood or charcoal has been traditionally used as fuel for fires, cooking and industry, which dates back to the early history of human civilization. In rural areas with no energy access, it remains a key source of domestic primary energy despite the health and environmental problems associated with its inefficient burning. Bioenergy is derived from various biological sources, called biomass. It is considere d a renewable energy source since biomass can be replenished on a regular basis. Bioenergy is energy from organic matter (biomass), in other words, all materials of biological origin that is not embedded in geological formations or fossilized. Bioenergy is energy generated from solid, liquid and gaseous products derived from biomass, wood, agricultural crops, and organic waste from municipal and industrial sources[1]. Biomass using modern technology differs from traditional biomass in two key characteristics; 1.The source of organic matter should be sustainable.
2.The technology used to obtain the energy, should limit or mitigate emissions of flue gases and account for ash residue management.

“The World Energy Council defines bioenergy to include traditional biomass for example forestry and agricultural residues, modern biomass and biofuels”. It represents the transformation of organic matter into a source of energy, whether it is collected from natural surroundings or specifically grown for the purpose. In developed countries, bioenergy is promoted as an alternative or more sustainable source for hydrocarbons, especially for transportation fuels, like bioethanol and biodiesel, the use of wood in combined heat and power generation and residential heating[2]. In developing countriesbioenergy may represent opportunities for domestic industrial development and economic growth.

1. **Characteristics of Bioenergy:**

(a). Bioenergy is a versatile energy source. In contrast to other energy sources,biomass can be converted into solid, liquid and gaseous fuels.
(b). Bioenergy is the largest renewable energy source–14% out of 18%renewables in the energy mix.
(c). Bioenergy supplies 10% of global energy supply.
(d). Bioenergy is shifting from a traditional and indigenous energy source toa modern and globally traded commodity.
(e). Climate change and energy independency are major drivers for bioenergydevelopment.
(f). Biofuels are the most viable and sustainable option in replacing oildependency.
(g).The future will be led by the need for renewables in transport followedby heating and electricity sectors.

2.Major Forms of Bioenergy:

The major forms of bioenergy includes biopower or bioelectricity, biofuels and energy for heating and cooling or thermal energy.

2.1 Biopower or Electricity: Biopower is electricity generated from combustion of biomass, either alone or in combination with coal, natural gas, or other fuel and termed as co-firing. Most biopower plants are direct-fired systems where biomass feedstocks are burned in a boiler to produce high-pressure steam that runs turbines connected to electric generators. The electricity produced can be distributed for industrial, residential, or commercial use. The steam generated from combustion of biomass can also be used to directly power mechanical processes in industrial settings. Technical challenges in biopower generation involve feedstock quality, boiler chemistry, ash deposition and ash disposal. However, these challenges are being resolved with the advancement of technology. Biomass co-fired in a coal power plant is having vast potential in meeting renewable energy standards and willbe helpful in reducing pollution from coal burning[3].

2.2 Biogas: "Biogas" is a gas produced by anaerobic fermentation of different forms of organic matter and is composed mainly of methane (CH_4) and carbon dioxide (CO_2). Main feedstock for biogas production are manure and sewage, residues of crop production (i.e.,straw), the organic fraction of the waste from households and industry, as well as energy crops including maize and grass silage. Biogas is supplied to a variety of uses or markets, including electricity, heat and transportation fuels[4]. In many countries, the gas is used for direct combustion in household stoves and gas lamps are increasingly common. However, producing electricity from biogas is still relatively rare in most developing countries. In industrialized countries, power generation is the main purpose of most biogas plants; conversion of biogas to electricity has become a standard technology. Leadingcountries in producing biogas include Germany, India and China.

2.3 Biofuels: Biofuel refers to solid, liquid, and gas fuels. Solid fuels are typically used for space heating via combustion. Liquid and gas fuels are used for transportation and industrial processes. Liquid and gas biofuels are produced through fermentation, gasification, pyrolysis, and torrefaction, Bioethanol and biodiesel are major forms of biofuel[5].

2.3.1 Types of Biofuels:

2.3.1.1. First-generation biofuel: Biofuels produced from oils, sugars, and starches originating in food crops are known as First-generation biofuel. First-generation biofuels are produced through relatively simple and established technologies. Liquid biofuels for transport like bioethanol and biodiesel are part of important strategies to improve fuel security, mitigate climate change and support rural development. Conventional biofuels which also referred to as first generation biofuels usually include ethanol from corn, sugarcane etc. and biodiesel from canola, jatropha etc.). To complement the conventional biofuels, recent advances are focused on the next generation of biofuels[6].

2.3.1.2 Advanced biofuels: Advanced biofuels, generally referred to as second or third generation biofuels are produced from a broad spectrum of predominantly non-edible biomass feedstock. The feedstock includes lignocellulose-based ethanol, hydrogenated vegetable oil, algae based biofuels and biogas. "Biogas" is a gas produced by anaerobic fermentation of different forms of organic matter and is composed mainly of methane (CH_4) and carbon dioxide. Typical feedstock for biogas production are manure and sewage, residues of crop production, the organic fraction of the waste from households and industry, as well as energy crops including maize and grass silage. Biogas is supplied to a variety of uses or markets, including electricity, heat and transportation fuels. In many countries, the gas is used for direct combustion in household stoves and gas lamps are increasingly common. However, producing electricity from biogas is still relatively rare in most developing countries. In industrialized countries, power generation is the main purpose of most biogas plants; conversion of biogas to electricity has become a standard technology. Leading countries in producing biogas include Germany, India and China.

2.3.1.3 Liquid Biofuels: Liquid fuels are the most portable of fuels. Liquid biofuels are produced from organic matter through one of several physical, biological or thermochemical processes, including fermentation, pyrolysis, gasification and catalytic conversion or direct extraction and transesterification. Liquid biofuels are also produced by anaerobic digestion and direct partial oxidation or gas synthesis. Fuels produced by the recombination of hydrogen and carbon are referred to as synthetic fuels or synfuels. The most developed liquid biofuels are ethanol, methanol and biodiesel[7].

3. Major Drivers of Bioenergy Development

A major driver for the development of bioenergy markets is mainly Green House Gas mitigation. Bioenergy has been successful in many developed countries and to a certain extent, some developing countries as well. Countries with high share of renewables also have a high share of bioenergy in their energy mix. Bioenergy has enabled countries in gradual decarbonization of the energy system and reduced dependency on fossil fuels. Earlier, the main drawback of bioenergy was security of supply and high import costs of fossil fuels. Now, the substitution of fossil fuels, and the reduction of fossil carbon emissions are major benefits for bioenergy. With the historic climate agreement in Paris at COP21 and COP26 can be considered as one of the most anticipated and the biggest international summits so far in the history of climate action.

It has renewed focus on renewables and also accelerated the investments in bioenergy. Much of current interest in bioenergy revolves around issues of energy security, energy independence, and perceived opportunities for economic growth and development. Finally, bioenergy offers countries that do not have significant natural hydrocarbon resources a potential opportunity to become net producers of energy products for export. To do this however, they need to develop the necessary industry and infrastructure and have sufficient land and water resources to support the economic production of the feedstock crops.

One of the most important benefits of biofuels is in the transportation sector. Electrification is another viable option. However, to reduce the emissions and to limit global warming to within 2°C in this century, biofuels are the most viable and sustainable option in replacing oil dependency.

4. Feed stocks Sources: Bioenergy Production

The supply of biomass can be classified into three sections–forestry, agriculture and waste. Although globally, some of the waste is mixed with materials of fossil origin, like fossil-based plastics, most waste consists of a large share of biogenic material (paper, wood, biogenic textiles, rubber, bio plastics, etc.), and there are large streams of waste and residues from agriculture, forestry, fishing, the food chain, and all connected industries. In most countries, the first step in developing a modern bioenergy sector is to better utilize these resources from wastes and residues. Bioenergy feedstocks are biomass-derived materials that are converted to energy through the application of microbial activity, heat, chemicals, or a combination of these processes. There are three main types of biomass materials from which bioenergy feedstocks are derived:

(i) Lipids: Lipids are energy-rich, water-insoluble molecules such as fats, oils, and waxes. Lipids are a feedstock source derived from non woody plants and algae. Soyabean (Glycine max), oil palm, and various seed crops such as sunflower (Helianthus annus) arecommon agricultural sources of oils for biodiesel.

(ii) Sugars or starches: Sugars and starches are the carbohydrates typically found in the edible portions of food crops, such as corn (Zea mays) grain, which are sources for first-generation biofuels.

(iii) Cellulose and lignocellulose: Cellulosic/lignocellulosic biomass is composed of complex carbohydrates and noncarbohydrate molecules typically found in the leaves and stems of plants. Cellulose/lignocellulose is of little or no food value to humans. Advanced biofuels therefore offer an opportunity to take these relatively low-value materials and use them in the production of high-value energy produces[8].

There are two broad categories of plants from which cellulosic/ lignocellulosic feedstocks are derived: woody and non woody. In addition to cellulose, many plants also contain hemicellulose and lignin. Hemicellulose is a large, complex carbohydrate molecule that helps cross-link cellulose fibers in plant cell walls. Lignin is a non carbohydrate polymer that fills the spaces between cellulose and hemicellulose. When cellulose, hemicellulose, and lignin are present together, they are referred to as lignocellulose. Hemicellulose can be broken down into fermentable sugar and then converted into ethanol and other fuels. Lignin is difficult to convert into other usable forms and is therefore considered a byproduct. The majority of biomass for bioenergy feedstocks comes from three sources: forests, agriculture, and waste. Algae is an important emerging sourceof bioenergy feedstocks.

4.1 Forest-Based Feedstocks for Bioenergy Production

Woody biomass from forests is the original source of bioenergy. It remains the most important source of fuel for cooking and space heating throughout the world, particularly among subsistence cultures. Around the world, woody biomass is used for cooking, production of electricity and heat for industries, towns and cities and production of liquid biofuels. The woody biomass is the sourceof over 10% of all energy supplied annually[9].

Overall woody biomass provides about 90% of the primary energy annually sourced from all forms of biomass. In general, only wood that is not merchantable as lumber or pulp is used in bioenergy production. There are two main ways low-grade wood is removed from forests for bioenergy use: as bark and as wood chips. Bark is typically burned to firewood kilns at mills, or it is sold in higher value markets such as landscaping materials. Wood chips, however, can be used directly as a solid fuel (for combustion) or they can be refined and densified into pellets.

4.2 Agriculture-Based Feedstocks for Bioenergy Production

Agriculture is a source of sugars, starches, lipids, nonwoody cellulosic materials, and woody materials (i.e., lignocellulosic biomass). Agriculture-based biomass comes from crops grown specifically for bioenergy production as well as agricultural residues. Agricultural residues are nonedible, cellulosic materials that remain after harvest of edible portions of crops. Bioenergy crops include annual crops grown for their sugars, starches, or oils, and perennial herbaceous nonfood plants grown for their cellulose. Agricultural residues include plant leaves and stems. Some annual crops, such as corn, can be dedicated bioenergy crops for both their grain and their cellulosic residues. Most of the world’s first-generation bioethanol is made from feedstocks derived from annual food crops. Annual row crops are grown and harvested in a single year and must be planted every year. Sugarcane and corn are the primary feedstock sources for first-generation bioethanol. However, bioethanol is also produced from cereal crops, sugar beets, potatoes, sorghum, and cassava as well. Sugarcane is the primary feedstock in Brazil, and corn grain is the primary feedstock in the United States. These two feedstock sources are converted into approximately 62% of the world’s bioethanol.

The primary agricultural sources of lipids for first-generation biodiesel are annual row crops soyabean, palm, and oilseed rape. Soyabean is the primary feedstock source for biodiesel produced in the United States, Europe, Brazil, and Argentina, which are world leaders in biodiesel production. Palm, a tropical plant, is the primary feedstock source in Southeast Asia (e.g., Malaysia and Indonesia), while oilseed rape is grown in Europe, Canada, the United States, Australia, China, and India. Inedible oil crops are being examined for commercial potential in second-generation biodiesel production, including castor and Camelina. Perennial crops are the primary sources of lignocellulosic biomass for second-generation biofuels. They have received considerable attention because they are not food crops, and they provide both long term yield potential and environmental benefits not usually achieved in annual row crop agriculture[10]. These potential environmental benefits include wildlife habitat, soil erosion prevention, and water quality improvement.

Perennial grasses in particular are of considerable value in advanced biofuels, as are fast growing trees such as hybrid poplars (Populus spp.) and willows (Salix spp.). Whether they are herbaceous or woody, perennial dedicated bioenergy crops are typically grown with some amount of agronomic intensity (e.g., inputs of fertilizer and pesticides), which is why they are considered as crops.

Crop residues also are an important source of cellulosic feedstocks. Crop residues include materials left in fields after crops have been harvested. For example, the stems, leaves, and stalks of corn leftover after harvest of grain, referred to as Stover, can be used in the production of cellulosic ethanol. Their use potentially limits the impacts of biofuels on food security. The amount of residue that is potentially available differs widely among crops. The use of agricultural residues must be carefully planned and managed due to their important role in soil erosion control and maintenance of soil quality, and their use as forage, fodder, and bedding for livestock.

4.3 Waste-Based Feedstocks for Bioenergy Production

Waste-based biomass includes organic materials leftover from industrial processes, agricultural liquid and solid wastes (e.g. manure), municipal solid wastes, and construction wastes. Many industrial processes and manufacturing operations produce residues, waste, or co-products that can be potentially used for bioenergy. The major sources of waste for bioenergy generation are:

1. Non woody wastes include waste paper, liquid leftover from paperproduction and textile manufacturing.

2.Agricultural wastes include byproducts of agro-industrial processes and manure from livestock. Agro-industrial processes such as animal processing, grain milling, starch production, and sugar production result in byproducts that may be used as bioenergy feedstocks. Bagasse, the fibrous material leftover from sugarcane and sorghum crushing in sugar production, is sometimes used as a fuel source for heat in sugar mills but it can also be converted to bioethanol.

Animal byproducts are used as feedstocks in anaerobic digesters to produce biogas. Biogas is a substitute for propane, kerosene, and firewood to produce heat and electric power. It is also compressed and liquefied for use as a transportation fuel. Livestock manureis converted into biogas via anaerobic digestion.

1.Municipal solid waste is a major source of biomass. Also called trash and urban solid waste, municipal solid waste is predominantly household or domestic waste. Municipal solid waste includes biodegradable waste, such as kitchen food waste and food packaging; clothing and toys; recyclable materials such as paper, plastics, and metals; appliances and furniture; and debris[11].

2.Most municipal solid waste is diverted to landfills, but in some locations it is incinerated to make electricity. Portions that are not incinerated can be converted to syngas through gasification. Syngas can be co-fired in boilers with coal, for example, to produceelectricity. Construction waste consists of wood, plastic, and metaldebris.

5. Overview of Conversion Technologies for Bioenergy

To make use of the energy available in biomass, it is necessary to use technology to either release the energy directly, as in direct combustion for heat, or to transform it into other forms such as solid, liquid, or gaseous fuel. There are three main types of conversion technologies currently available. These technologies may also be used in combination[12].

5.1 Thermal:

- As the name indicate, thermal conversion processes use predominantly heat to convert biomass into other forms.
- Thermal conversion processes include combustion, pyrolysis,torrefaction, and gasification.
- Pyrolysis is the decomposition of biomass at high temperaturesin the absence of oxygen.
- Torrefaction is pyrolysis at low temperature.
- Gasification is the conversion of solid biomass into various gasesusing heat and varying amounts of oxygen.

5.2 Chemical: Chemical conversion involves the use of chemical agents to convert biomass into liquid fuels.

5.3 Biochemical:

- Biochemical conversion involves the use of enzymes of bacteria or other microorganisms to break down biomass through the processes of anaerobic digestion, fermentation, or composting
- Although relevant technologies exist (and continue to be developed), some are not yet cost effective, particularly for the large-scale conversion of cellulosic biomass.
- In the biological conversion of lignocellulosic feedstocks, pretreatment is required. Pretreatments break down cellulose and hemicellulose into sugars and separate lignin and other plantconstituents from fermentable materials.
- Pretreatment technologies are physical, biological, and combinatorial; the form of pretreatment used will depend on the nature of the feedstock.
- Physical pretreatment includes gamma-ray exposure; chemical pretreatment methods include the use of acids, alkali, and ionic liquids; and biological methods include use of microorganismsto degrade lignin and hemicelluloses.

6. Economical, Social, Ecological and Environmental Impacts of Bioenergy

There are many potential benefits of bioenergy, as well as many potential negative effects.

6.1 Economic Impacts: Bioenergy and renewable energy may be viable economic development options for communities that can grow dedicated energy crops and develop energy industries to process those crops into power or fuel. The development of a bioenergy industry may be particularly well suited for local economies. Economic benefits must also be weighed against impacts to water supply and other resources. Each community and situation is different, and local decisions around the choice of energy crops, processing systems, and markets will define the economic benefits, while policy can provide incentives and influence outcomes.

6.2 Ecological and environmental impacts: As far as ecological and environmental impacts of bioenergy are concerned Bioenergy can have positive and negative effects on ecosystems and species within them, and geophysical systems such as water and climate. The overall net impact can also be positive or negative depending on the particular system or project under consideration. Specific impacts and net impacts depend on

- the feedstock type
- biomass production system
- conversion technology
- transportation/distribution system
- use or disposal of co-products and byproducts etc.

Major ecological and environmental impacts of bioenergy are on land use change, greenhouse gas emissions and climate change, wildlife and biodiversity, invasive and transgenic plants, marginal lands, and water quantity and quality. Bioenergy production affects water availability and quality through water use in biomass production and water use during feedstock conversion. Emission of air pollutants from biopower combustion and burning of biofuels also potentially impacts water quality, mostly via precipitation. Bioenergy also affect food security. Sustainability analyses of bioenergy is thus require a multitactic approach for resolving the multiple challenges of providing food, energy, and environmental protection for the world population.

7. Challenges in Sustainable Bioenergy Production

There are many challenges for sustainable production of bioenergy. Many governments, international agencies, and nongovernment organizations at different levels have produced many white papers and various guidelines in an effort to encourage sustainable practices in biomass production. Although there is sufficient supply of biomass from forest, agricultural, and waste resources for meeting current and future demands for bioenergy, there is no scientific consensus regarding the simultaneous fulfillment of food and feed needs. Bioenergy feedstock production involves risk. The agricultural production of biomass involves more risk than forest based production because of seasonal weather uncertainties (e.g., flood, drought, hail), fluctuating yields and rapidly fluctuating prices. Many bioenergy feedstocks have relatively high water requirements when grown at commercially viable levels.

Expansion of biomass production, processing into feedstocks, handling, transportation, and storage, if done sustainably, may provide supply/value chains that support renewable energy goals while enhancing rural livelihoods. Biomass supply is potentially available to meet renewable energy goals. However, land availability, competing land uses, yield potential, yield gaps, producer profitability, and other important constraints influence the potential supply of biomass. Ultimately, decision-makers at all levels must balance the costs, benefits, advantages, and disadvantages among specific biomass types and production systems to make informed decisions with regard to the desired goals for the present and the future.

7.1 Challenges in Meeting the Demand

Challenges in meeting the demands for bioenergy include competition for land, water, and other resources needed to produce plant-based feedstocks. As a biofuel feedstock, algae provides a very attractive alternative option. Algae does not compete with food, land, and water resources. The algae fuel yield is also estimated to be 100 times more than other biofuel sources. The low-temperature fuel properties and energy density of algae fuel make it suitable as jet fuel, home heating oil, and general transportation fuel for colder regions. In addition, it ensures a continuous supply, can capture waste CO_2 forgenerating biomass, can manage farm nutrients runoff, and can treat wastewater.

Critical hurdles in terms of algae biofuel production and big economic barriers in the production of algal-based drop in biofuel include the cost-efficiency involved in the development and production of algae biomass for biofuel. Now robust oleagenous algae strains are availabe that can grow in nonsterile environments, such as dairy farm manure wastewater and other lignocellulosic materials (e.g., residues: corn stover, straw, manure, rural food industry wastewater, molasses, bagasse, wood chips/bark, grasses, etc.) to efficiently use low-cost nutrient sources of mainly carbon, nitrogen, and phosphorus. Micro and macroalgae are therefore being explored as commercially viable feedstocks for third generation biofuels. The cost-effectiveness of commercial-scale systems would be the determining factors in developing advanced biofuels.

8. India's National Policy on Biofuels

In recent years, India has become a pioneer in climate protection and is one of the few countries to have performed exceptionally on the mitigation goals of NDCs. Hon'ble Prime Minister, Shri Narendra Modi, in his speech at COP26 highlighted how India expects developed nations to provide climate finance of $1 trillion while also stating the nation's five point resolution. India will

1. Bring its non-fossil based energy capacity to 500 GW by 2030 By 2030, fulfil 50% of its energy requirement through renewable energy cut down its net projected carbon emission by 1 billion tones till 2030
2. Reduce carbon intensity of its economy by more than 45% by2030, and
3. By 2070, India will be 'net-zero'.

India currently ranks 4th worldwide in installed renewable energy capacity. Additionally, India has successfully produced energy from non-fossil fuel sources by more than 25% in the last 7 years thereby reaching 40% of the country's energy mix[13].

8.1. National Policy on Biofuels 2018

In order to promote biofuels in the country, a National Policy on Biofuels was made by Ministry of New and Renewable Energy during the year 2009. Globally, biofuels have caught the attention in last decade and it is imperative to keep up with the pace of developmentsin the field of biofuels.

Biofuels in India are of strategic importance as it augers well with the ongoing initiatives of the Government such as Make in India, Swachh Bharat Abhiyan, Skill Development and offers great opportunity to integrate with the ambitious targets of doubling of Farmers Income, Import Reduction, Employment Generation, Waste to Wealth Creation. Biofuels programme in India has been largely impacted due to the sustained and quantum non-availability of domestic feedstock for biofuel production which needs to be addressed14].

8.1.1.Salient Features:

1. The Policy categorises biofuels as "Basic Biofuels" viz. First Generation (1G) bioethanol & biodiesel and "Advanced Biofuels"- Second Generation (2G) ethanol, Municipal Solid Waste (MSW) to drop-in fuels, Third Generation (3G) biofuels, bio-CNG etc.to enable extension of appropriate financial and fiscal incentives under each category.
2. The Policy expands the scope of raw material for ethanol production by allowing use of Sugarcane Juice, Sugar containing materials like Sugar Beet, Sweet Sorghum, Starch containing materials like Corn, Cassava, Damaged food grains like wheat, broken rice, Rotten Potatoes, unfit for human consumption for ethanol production
3. Farmers are at a risk of not getting appropriate price for their produce during the surplus production phase. Taking this into account, the Policy allows use of surplus food grains for production of ethanol for blending with petrol with the approval of National Biofuel Coordination Committee.
4. With a thrust on Advanced Biofuels, the Policy indicates a viability gap funding scheme for 2G ethanol Bio refineries of Rs.5000 crorein 6 years in addition to additional tax incentives, higher purchaseprice as compared to 1G biofuels.
5. The Policy encourages setting up of supply chain mechanisms for biodiesel production from non-edible oilseeds, Used Cooking Oil,short gestation crops.
6. Roles and responsibilities of all the concerned Ministries/ Departments with respect to biofuels has been captured in the Policy document to synergise efforts.

8.1.2.Expected Benefits:

- **Reduce Import Dependency**: One crore lit of E10 saves Rs.28 crore of forex at current rates. The ethanol supply year 2017-18 is likely to see a supply of around 150 crore litres of ethanol which will result in savings of over Rs.4000 crore of forex.
- **Cleaner Environment**: One crore lit of E-10 saves around 20,000 ton of CO_2 emissions. For the ethanol supply year 2017-18, there will be lesser emissions of CO_2 to the tune of 30 lakh ton. By reducing crop burning & conversion of agricultural residues/wastes to biofuels there will be further reduction in Green HouseGas emissions.
- **Health benefits**: Prolonged reuse of Cooking Oil for preparing food, particularly in deep-frying is a potential health hazard and can lead to many diseases. Used Cooking Oil is a potential feedstock for biodiesel and its use for making biodiesel will prevent diversion of used cooking oil in the food industry.
- **MSW Management**: It is estimated that, annually 62 MMT of Municipal Solid Waste gets generated in India. There are technologies available which can convert waste/plastic, MSW to drop in fuels. One ton of such waste has the potential to provide around 20% of drop in fuels.
- **Infrastructural Investment in Rural Areas**: It is estimated that, one 100klpd bio refinery will require around Rs.800 crore capital

  investment. At present Oil Marketing Companies are in the process of setting up twelve 2G bio refineries with an investment of around Rs.10,000 crore. Further addition of 2G bio refineries across the Country will spur infrastructural investment in the rural areas.
- **Employment Generation**: One 100klpd 2G bio refinery can contribute 1200 jobs in Plant Operations, Village Level Entrepreneurs and Supply Chain Management.
- **Additional Income to Farmers**: By adopting 2G technologies, agricultural residues/waste which otherwise are burnt by the farmers can be converted to ethanol and can fetch a price for these waste if a market is developed for the same. Also, farmers are at a risk of not getting appropriate price for their produce during the surplus production phase. Thus conversion of surplus grains and agricultural biomass can help in price stabilization[15].

8.2 Amendments to the National Policy on Biofuels -2018

The "National Policy on Biofuels-2018" was notified by Ministry of Petroleum and Natural Gas on 04.06.2018 in supersession of National Policy on Biofuels, promulgated through the Ministry of New & Renewable Energy, in 2009.

Due to advancements in the field of Biofuels, various decisions taken in the National Biofuel Coordination Committee (NBCC) meetings to increase biofuel production, recommendation of the Standing Committee and the decision to advance to introduce Ethanol Blended Petrol with up to twenty per cent ethanol throughout the country from 01.04.2023, amendments are done to the National Policyon Biofuels.

The following are the main amendments approved to the National Policy on Biofuels:

- to allow more feedstocks for production of biofuels,
- to advance the ethanol blending target of 20% blending of ethanolin petrol to ESY 2025-26 from 2030,
- to promote the production of biofuels in the country, under the Make in India program, by units located in Special Economic Zones (SEZ)/Export Oriented Units (EoUs),
- to add new members to the NBCC.
- to grant permission for export of biofuels in specific cases, and
- to delete/amend certain phrases in the Policy in line with decisions taken during the meetings of National Biofuel

Coordination Committee.

The Government has unveiled a new National Biofuel Policy (2018) that incentivises biofuel generation through multiple measures. Major steps include encouragement of biofuel generation from excess crop production and setting apart Rs 5000 crores viability gap funding to establish second generation ethanol refineries. The Policy widens the range of feedstocks that can be used for producing ethanol and allows the use of damaged grains that is unusable for food purposes for ethanol production. As per the policy, besides sugar molasses, beet, sorghum, corn, damaged grains etc. can be used for ethanol production.

Following are the main features of the National Policy on Biofuels 2018. The Policy was brought by the Ministry of New and Renewable Energy (MNRE). MNRE previously unveiled a National Biofuel Policy in 2009. Main features of the Policy includes:

Categorization of Biofuels: In this Biofuels are categorized into:

'Basic Biofuels' like First Generation (1G) bioethanol & biodiesel and

'Advanced Biofuels'–Second Generation (2G) ethanol, Municipal Solid Waste (MSW) to drop-in fuels, Third Generation (3G) biofuels, bio-CNG etc.

1. **Expansion of the scope of raw materials for ethanol production:** The Policy expands the type of bio-raw materials for ethanol production by including Sugarcane Juice, Sugar containing materials like Sugar Beet, Sweet Sorghum, Starch containing materials like Corn, Cassava, Damaged food grains like wheat, broken rice, Rotten Potatoes etc. which are unusable for human consumption.
2. **Surplus food grains can be used for ethanol production:** During excess production, crop prices fall. Here, the Policy allows use of surplus food grains for production of ethanol with the approval of National Biofuel Coordination Committee. For the generation of Advanced Biofuels, the Policy proposes a viability gap funding scheme for 2G ethanol Bio refineries with Rs.5000 crore in 6 years. In addition to this, additional tax incentives, higher purchase price as compared to 1G biofuels will be given for 2G ethanol generation. The Policy encourages setting up of supply chain mechanisms for biodiesel production from non-edible oilseeds, Used Cooking Oil, short gestation crops etc. For the success of the policy, roles and responsibilities of all the concerned Ministries/ Departments regarding biofuels has been ensured.
3. The National Policy also specifies the various benefits from the use of biofuels. These include reduction of import dependency, promoting cleaner environment, ensuring health benefits, waste management benefits, raising of infrastructure in rural areas besides providing additional income to the farmer[16].

Conclusions: Bio energy have attracted considerable scientific and public attention as a promising alternative to fossil fuels by energy are made from biomass through processes such as chemical biochemical or hybrid conversion. bio energy avoid the environmental drawbacks associated with the consumption of fossil fuels. However, A very small fraction of its potential has been exploited so far. There are still huge quantities of bio-residues around the world that can be converted into bioenergy. India has become a pioneer in climate protection. India currently ranks 4th worldwide in installed renewable energy capacity additionally India has successfully produced energy from non fossil fuel sources by more than 20% in the last 7 year there by reaching 40% of the countries energy mix. It was expected that India will bring its non fossil base energy capacity to 500 GW by 2030 and full fill 50% of its energy requirement through renewable energy. It is also aimed to cut down India's net projected carbon emission by 1 billion tons till 2030 and reduce carbon intensity of India's economy by more than 40%. Presently, Bioenergy in India is of strategic importance as it augers well with the ongoing initiatives of the Government such as Make in India, Swachh Bharat Abhiyan, Skill Development and offers great opportunity to integrate with the ambitious targets of doubling of Farmers Income, Import Reduction, Employment Generation, Waste to Wealth Creation. Biofuels programme in India has been largely impacted due to the sustained and quantum non-availability of domestic feedstock for biofuel production which needs to be addressed.

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