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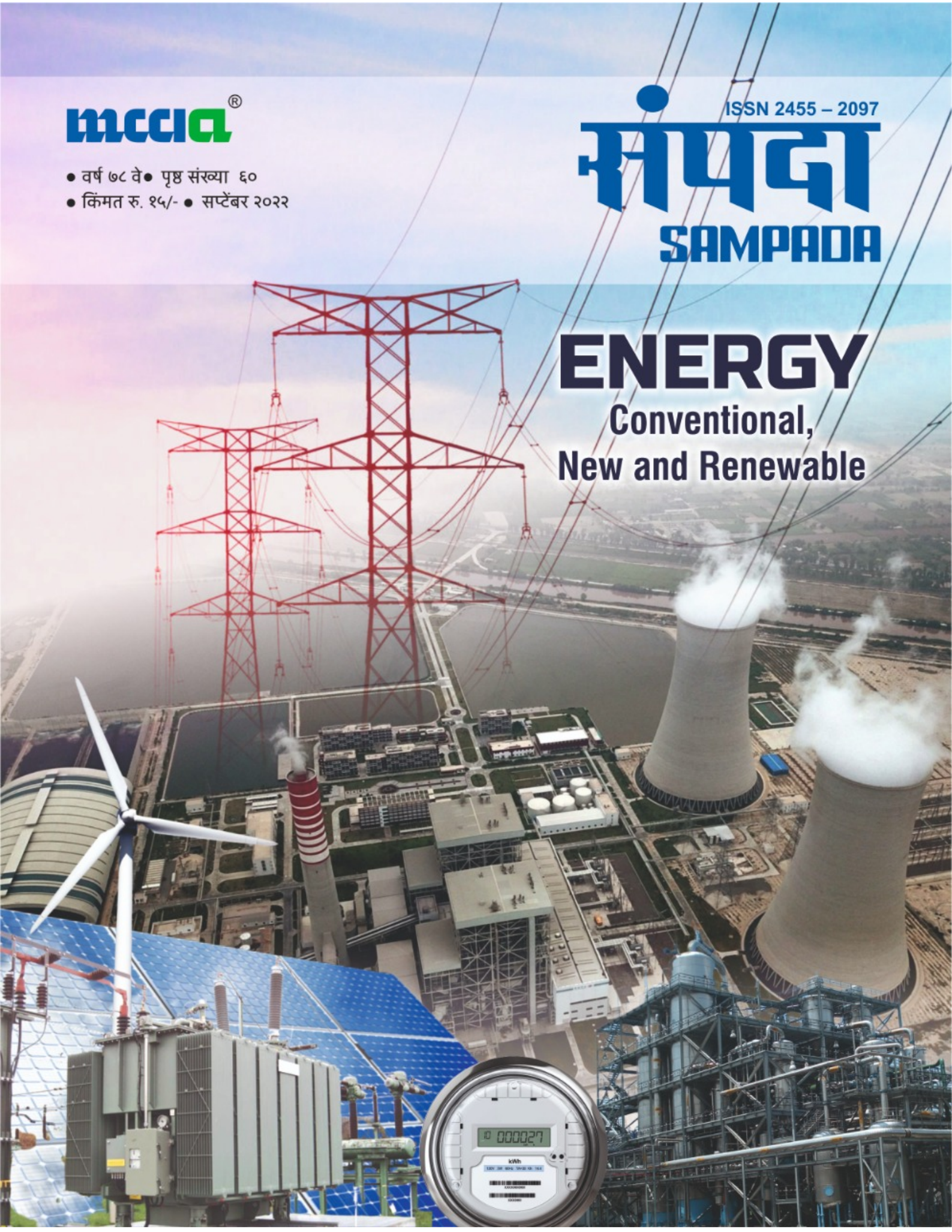

From Agri Residues to Ethanol as testament of 'Waste to Wealth'

- Dr. Ravindra Utgikar

A. Climate change Mitigation:

Countdown for the COP27 Climate Change summit to be held at Cairo in November 2022 has already begun. Several climate calamities like heat waves in Europe, massive floods in South Asia this year have yet again given us a wake-up call that we have to accelerate sustainable climate actions.

Wading through the deluge of debates, articles, and podcasts during COP26, it has become evident that the current efforts of merely reducing the rate of GHG emissions are just not adequate. According to the latest assessment of Inter-governmental Panel for Climate Change (IPCC), the world can add only 500Bn metric tons of carbon to the existing stock of carbon in the atmosphere to cap the increase in temperature rise on average at 1.50C above pre- ndustrial levels. However, we will easily overshoot that target, if we take into consideration the Nationally Determined Contributions (NDCs) that countries have committed towards UNFCCC to bring their net emissions to nil. Most of the removal of carbon from the atmosphere to achieve pre-industrial levels will take place in the next couple of centuries.

As a climate change mitigation measure, we need to embrace advanced low carbon technology solutions to the fullest immediately. Some hard-to-abate sectors (e.g., cement and steel) and transportation have proven to be particularly recalcitrant. In this article, we are pondering on green energy solutions as sustainable climate action.

B. Global energy landscape:

The global energy landscape continues to be dominated by fossil fuels. Fossil fuels are derived from resources like coal, oil and natural gas. These fossil resources are developed over the course of centuries and extracted from deep under the ground using expensive and environmentally damaging processes. Fossil fuels are also being consumed at a far faster rate than they are being produced. Meaning, being a finite resource, sooner or later the planet's supplies

of fossil fuels will be completely exhausted – especially if we continue to deplete them at the current rate. Furthermore, over 73% of human-caused greenhouse gas emissions are attributable to energy consumption. According to the International Energy Agency (IEA) oil, coal, and natural gas account for approximately 81.3 % of the global energy mix. Biofuels and waste streams account for 9.3 % whereas nuclear, hydropower, and other sources account for 9.4 % respectively in the overall energy mix.

C. Energy transition as the saviour:

Rapid industrialization in pursuit of economic growth, increase in consumption due to enhanced standard of living and population growth have led to a rising energy demand. This demand is met by consumption of fossil fuels which in turn results in an increase in greenhouse gas (GHG) emissions causing global warming and climate change. Extreme weather events such as heat waves, devastating floods and droughts etc. are causing irrevocable and dire consequences. Concerns over food and water security, damage to property, & economy and importantly the loss of lives and livelihoods are threatening very existence of mankind.

To keep global warming below 1.5°C – as called for in the Paris Agreement, UN has backed a global campaign, 'Race to Zero' to take rigorous and immediate action to halve emissions by 2030 and reach net zero by 2050

One of the very promising solutions is moving away from fossil fuels and adopting low-carbon energy derived from renewable sources. Shift from hydrocarbon-based economy to carbohydrate-based economy is the need of the hour and this evolution is gaining momentum.

In this regard, energy transition has emerged as a central theme of sustainable climate action.

D. Waste to wealth:

Agricultural waste is becoming a mammoth problem for India. Not knowing what to do with the stubble post-harvesting, many Indian farmers, simply burn it as it's the easiest way to ready fields for next season. This causes air pollution and brown clouding over cities which is a known health hazard. Moreover, torching of agri-residue is significantly contributing to climate change given massive GHG emissions. However, there is a way to address this situation and that is converting this agricultural waste into wealth – Biofuels!

Biofuels simply put, are low carbon fuels both in liquid or gaseous form, produced from agricultural resources. Biomass is subjected to chemical reactions, fermentation and heat to ensure that the starch in the plants turns first into sugars, then into alcohol. This alcohol is then refined using a sophisticated process to bio-based fuel that is viable for use the engine of vehicles. Since these types of fuels are continually being replenished naturally by the cycle of life, they are considered as renewable sources of energy. That makes them an attractive alternative to fossil fuels.

Depending on the feedstock and production technology used, Biofuels can be classified as first-(1G), second-(2G), and third-generation(3G) biofuels. Bioethanol is finding increasing traction worldwide as an attractive strategy to decarbonize transportation sector. After industry, it is second largest consumer of energy and also emitter of GHG.

The first generation(1G) /conventional ethanol industry is well established all over

the world and more than 110 billion liters (~29 BGPY/88MTA) of ethanol is being produced every year. This eliminates around 70 million metric tonnes of CO2 emissions. In India, 10% ethanol blending target was achieved 5 months ahead of target date. In fact, Hon. Prime Minister Shri Narendra Modi announced that in the last seven-eight years, the country has saved Rs 50,000 crore in forex outflows by blending ethanol with petrol.

Success of 1G ethanol as low carbon renewable transportation fuel to decarbonize the sector as sustainable climate action spurred huge requirement globally. This increasing demand of biofuels worldwide that 1G ethanol is unable to fulfill considering limitations on feedstock and biomass supply chain management. What if we could amplify the emissions reductions many times over by producing ethanol by deploying agricultural waste as a feedstock that is far more abundant and is currently of low value. That's how second generation (2G) bioethanol technology utilizing cellulose as feedstock, was conceived and developed.

E. 2G Bioethanol :

Let's take a closer look at 2G Bioethanol.

2G technology deploys processes that extract useful feedstock from this woody or fibrous biomass, which is predominantly composed of plant cell walls. In all vascular plants, the useful sugars of the cell wall are bound within the complex carbohydrates (polymers of sugar molecules) hemicellulose and cellulose but made inaccessible for direct use by the phenolic polymer lignin. 2G ethanol is made by extracting sugar molecules from the carbohydrates using enzymes, steam heating, or other pre-treatments. These sugars can then be fermented to produce ethanol in the same way as 1G ethanol production. Important by-product of this process is lignin which can be burned as a carbon neutral fuel to produce heat and power for the processing plant. Another important co-product from 2G Bioethanol biorefinery is bio-manure that contributes to the fertility of soil by adding organic matter and provides essential vital nutrients for the growth of the plants. Bio-bitumen is yet another bioproduct that is produced from lignin that has wide applications in road construction as binder Cellulose is the most abundant molecule around us, of which quite a large part is residue or waste. Advanced/Second generation/2G Bioethanol produced from this cellulosic feedstock is a low-carbon fuel. With this backdrop, there is a strong rationale for the industry to ramp up the production capacity of 2G Bioethanol.

F. 2G Bioethanol in India:

On occasion of World Biofuels Day (10th Aug) this year, India's Hon. Prime Minister Shri Narendra Modi unveiled first of its kind & Asia's First 2G Bioethanol Bio-Refinery of Indian Oil Corporation Limited (IOCL) at Panipat Haryana. Praj is the technology licensor and EPCM partner for this landmark project. This project is based on Praj's proprietary technology EnfinityTM processing Rice Straw as feedstock for production of Ethanol.

Spanning across 35 acres, this 2G Bioethanol Bio-Refinery is capable of processing 2 lakh tonnes of rice straw annually to generate around 3 crore litres of Ethanol using Praj's proprietary technology. While benefiting more than 1 lac farmers, this Bio-Refinery is expected to create around 1500 jobs for rural youth. Importantly, it will help address the major challenge of stubble burning related pollution by eliminating around 320,000 MT of CO2 every year which is equivalent to

replacing nearly 63,000 cars on road annually. This 2G Bio-Refinery alone will save foreign exchange worth INR 55 – 60 crores every year that is therwise incurred on fuel imports. This project will give boost to 'Make in India' initiative & help achieve 20% ethanol blending For India, 2G Bioethanol will also help to move closer to its goal of energy security, as it boosts the volume of auto fuel and reduces, to that extent, dependence on oil imports. India achieved its target of an average of 10% blending across the country five months in advance in June this year. Subsequently, the government amended the National Biofuel Policy, 2018, which, among other things, advanced the ethanol blending target of 20% in petrol to 2025-26 from 2030 earlier. This will require a boost in biofuel production, for which this golden waste can be used as a feedstock.

Validation:

Three Fortune 500 energy companies have already shown their confidence by signing licenses for Praj's EnfinityTM technology for their commercial-scale projects.

In addition to EnfinityTM, Praj offers CellunitiTM technology in collaboration with Sekab, Sweden. CellunitiTM harnesses soft wood from forestry residues to produce cellulosic sugars, biofuels & chemicals. Both CellunitiTM & enfinityTM technologies are also useful for production of sustainable aviation fuels (SAFs) & marine biofuels paving the way for greening these sectors too.

G. Conclusion

Success of 2G Bioethanol Biorefinery is expected to open floodgates for similar projects not just in India but around the world. In fact, along with this project, Praj is also setting up similar projects for Hindustan Petroleum Corporation Limited (HPCL), Bhatinda, Punjab and Bharat Petroleum Corporation Limited (BPCL), Bargarh, Orissa.

There are numerous benefits of 2G Bioethanol biorefinery projects. They not only help fulfill NDCs but also accelerate the 'Race-to-Zero' campaign towards carbon neutrality. 2G Bioethanol Bio refineries are typically set up in the proximity of agricultural farms to optimize logistic cost of feedstock. In the process they bolster rural economy by creating employment and entrepreneurship opportunities besides helping curb migration from villages to urban cities. Harnessing captive bio-based resources facilitates India's pursuit of energy self-reliance, aligned with Prime Minister's vision of energy independence.

Plants use surplus biomass and agricultural waste to produce ethanol, which is then blended with petrol. This helps India cut down on its crude oil imports, cut CO2 emissions, dispose off agri-stubble, and increase farmers' income, among others.

Ill-effects of climate change have accelerated the need for harnessing green technologies considering their positive impact on environment. 2G Bioethanol technology stands as an excellent testament of 'Waste to Wealth' providing us mankind glimmer of hope in the battle against climate change.

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