Editorial Article

Hydrogen Economy: Are we ready?

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The planet has witnessed an extraordinary economic rebound after the pandemic during the last couple of years. However, the cost of energy started to increase dramatically, and the global energy markets affected due to the war between Ukraine and Russia. The markets were further shaken due to the present crisis in the Middle East after the escalation of hostilities between Israel and Palestine. The prices of various energy forms such as natural gas have reached record highs and countries like Sri Lanka were severely affected. The situation was aggravated in Sri Lanka due to economic mismanagement, corruption and inefficient administration resulting in an irreversible economic meltdown. The depletion of foreign reserves coupled with devaluation of the currency inhibited the buying power of material in the international market. Out of many commodities, energy was the critical factor due to its multimodal influence for sustainable growth of the country. The enormous cost of energy has contributed to high inflation resulting in increasing poverty levels of a majority of families in Sri Lanka. The damage incurred to industry was unimaginable as most of the small and medium size enterprises were forced to shut down while other companies had to curtail the output, resulting in reduced GDP. The country has therefore experienced the highest fuel and electricity prices during the last year mainly due to the dependence of a fossil fuel-based economy. The country witnessed long power cuts and power shortages during the last couple of years due to the dependence of oil or coal imports for power generation. The whole world is moving towards clean energy technologies due to the oil crisis in the world. In this context, renewable energy sources such as solar power, wind power, hydropower and tidal power play a major role in contributing towards sustainable power generation. In addition, the energy from renewable sources prevents air pollution. As a country are we exploring the true potential of these avenues or are we seriously considering exploration of new energy sources? It is predicted to experience a shortage of fossil fuels in the next few decades due to the depletion of finite petroleum reserves. Therefore, scientists have taken a tremendous step in diverting their attention to alternative sustainable fuel technologies. In this context hydrogen plays a major role in replacing fossil fuel sources in a range of applications.

A hydrogen economy does not mean the total replacement of other energy sources. This term has a broader meaning, and the emphasis is given to the role that hydrogen can play alongside other environmentally harmful technologies to slowly phase out the dependency on fossil fuels. This will allow countries like Sri Lanka to detach from the total dependency of fossil fuels in the automobile industry. A hydrogen-based economy, however, requires the use of advanced technologies for economical and environmentally clean production, storage, and safe transport of hydrogen fuel. Shifting from fossil fuels to hydrogen offers major benefits in terms of pollution and energy security. The change to a hydrogen economy will not happen overnight, mainly due to the technological obstacles in developing new materials and methods for producing and storing hydrogen. Hydrogen is attractive as an

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energy carrier mainly due to its energy content which is about three times that of liquid hydrocarbons. Hydrogen can be combusted with oxygen in a fuel cell configuration to release energy and yield water with no air pollution. This is an attractive feature to reduce carbon footprint and to provide a pollution free transportation system in overcrowded and congested metropolitan areas. In addition, hydrogen can be produced from various sources including water, thereby reducing the dependence on fossil fuels.

Hydrogen is predicted to play a major role in power generation, especially in the automobile industry. The advantages of using hydrogen as a fuel are remarkable; however, the production of fuel cell powered automobiles is challenging. Many major car companies have already developed hydrogen powered vehicles which are currently being used in many countries. Japan and South Korea are at the forefront in this business. Toyota Mirai and Hyundai Nexo are two examples which dominate the world market for fuel cell-based cars. Recently Toyota introduced the GR Yaris H2 which is an advanced hydrogen powered car. The major difference in new technology is unlike the fuel cell technology; this car uses hydrogen as a combustible fuel in a traditional combustion engine. However, due to the technological obstacles the hydrogen powered cars are rarer in comparison to electrical vehicles. One reason is that ordinary motorists are unable to acquire hydrogen in a convenient and safe manner due to the lack of infrastructure. In addition, there are issues with hydrogen storage inside cars. Scientists believe that hydrogen storage is the key to enabling technologies on which a future hydrogen economy may rest. The public will accept hydrogen as a transportation fuel only when the technological barriers are overcome to meet the demand for onboard safe storage of the gas in an automobile in suitable quantities. The modern cars can travel a few hundred miles on a tank of gasoline and can be refueled in a few minutes. The EV technology is in full force and overwhelmingly popular in developed countries. Various countries have set stringent targets for the performance of hydrogen-powered cars which are coming to the market. The electrical vehicle tech giant Elon Musk once ridiculed the fuel cell-based cars as ‘fool cell’. However, recent comments by him indicate that fuel cell-based technology has a huge potential in the future automobile industry. Presently, the hydrogen fuel cell technology is more expensive than EV technology. However, the USA and Europe are investing heavily in hydrogen-based technologies due to potential other applications.

Over the past few decades, materials research has received prominent attention due to the growing demand for hydrogen production and storage methodologies. The exponential increase of research activities in the field is due to the growing recognition of the negative consequences of petroleum-based energy dependency. Nanotechnology will play a major role in developing these materials for both production and storage of hydrogen. Owing to the fascinating size-dependent properties of nanomaterials, the fields of nanoscience and nanotechnology have opened novel fundamental and applied frontiers in materials science and engineering. Nanotechnology plays a pivotal role in developing catalysts for producing hydrogen through water splitting using solar energy. Water is a major source of hydrogen and Sri Lanka is abundantly blessed with fresh water. Sri Lanka is also blessed with solar energy throughout the year except for rainy seasons. Various methodologies have been developed to split water utilizing solar energy; however, the work is still at the developing stage. Breakthrough discoveries in this area are yet to happen and could originate anywhere in the world. We hope that our water bodies will be protected for future generations as water will play multiple roles in our lives, including water for human consumption, for various activities and most importantly, to produce hydrogen which will be a major energy source in the future. This can only be achieved through a long-term vision towards science and technology in the country. Are we ready to embrace the hydrogen economy? Are we aware of the technological singularity and the disruptive technologies which will result in unforeseeable consequences for human civilization? The answer for both questions is ‘NO’.

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