



P-ISSN: 2349-8528

E-ISSN: 2321-4902

IJCS 2018; 6(3): 2588-2591

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Received: 17-03-2018

Accepted: 21-04-2018

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A Review: Fuel cell a sustainable future

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Abstract

The paper discuss about the environmental, sustainable aspects, renewable energy and fuel cell technologies as one of the potential things to continuously growing pollutants, hazards, natural resources degradation, human health, risks and climatic changes. From a basic house hold work to huge industrial tasks every part requires the supply of energy. Energy production is the major issue. Every process needs energy to get accomplished. For our energy requirements we are polluting environment along with the depletion of conventional sources and fossil fuels. We need to look for the reliable source of fuel and renewable energy. The fuel cell technology is a way to greener cities. The paper includes Sustainable development, key factors and criteria that are essential for sustainable development, fuel cells as hydrogen energy systems, sustainable development and thermodynamics, hydrogen safety and myths about hydrogen.

Keywords: Energy, fuel cell, life cycle assessment, environment, sustainable development

1. Introduction

We envisage a future where energy demands are fulfilled in an environmentally viable way. There are available technologies which have the potential to be the solution to the crisis and barriers to the environment. Energy is the most important factor which is used inevitably. It is considered to be the connecting point between nature and society. There are many critical issues like chronic effects, human health and degradation of resources. Recently there were developments and newer technologies which are proficient enough to be the solution to this problem. Here, considering this the technologies involving hydrogen energy systems. Hydrogen can produce miracles to solve the pollution problems and can produce the energy with no emissions from renewable energy sources. There are many factors that are considered like performance, environmental renewable systems, social acceptability and concept of sustainable development. The hydrogen fuel cell has been found the best ever technical concept which can compete with the ongoing energy producing systems. This is conceptual study involving both the socio economic factors and environmental concerns. It is often said that fuel cell technology is considered the most reliable future keeping in mind the present scenario of environment conditions. It is simple in nature with basic fundamental of electrochemical reactions. It involves conversion of chemical energy from fuel into electricity. The only by-products of the operation is water and water vapours. By the simple reactions of hydrogen and oxygen, the production of electricity is done. This is playing a crucial role in contribution to lessen the reductions of green house gases but also found to fulfil the desirable demands of power and also improving the air quality. Hence, it is proven that it is providing benefits in every aspect and maintaining the sustainability of atmosphere. They are truly found to be the viable option to be in the market and has full potential to grade up ongoing technologies.

2. Sustainable Development

This is an organising concept of meeting the mankind needs and development along with it sustaining the ability to provide natural resources with the socio economic demands. As a result of which state of society and their quality of living is improved. It is the principle based on stability of the environment. Without undermining the integrity it is the concept which provides the fulfilment of energy demands. It is a clean and affordable development utilizing the resources like wind energy and other renewable energy resources.

As they are abundantly found in nature, we need to look after such energy systems which are long term existing. They do not even provide small impact on environment.

Environmental impact is found to be the greatest factor point in this aspect. It is the relation between how much energy is utilized and how much energy is consumed in an effective way. It is ideally consider that there should be no harmful pollutants emission during the process and also no effects on the atmosphere is generally focused. There are various hydrogen systems which has these features are compatible. The implementation of sustainable development adding with the concept of hydrogen fuel cell technology with the fact to meet the growing demand is the best solution found till. There are some of the points which can be given focus so that the combination of sustainability and hydrogen cell can be made mire stronger. They are as follows:

- Spreading information about sustainable development with hydrogen fuel technology and public awareness of these combinations,
- Sustainability education and training in the terms of environmental impact,
- Appropriate energy production and energy strategies for better efficiency,
- Promoting environmentally sustainable technologies which gives no harm to atmosphere,
- Clean hydrogen production technologies with economic values,
- Development of sustainable hydrogen economy infrastructure providing many areas to be sound economically,
- Commercially viable and potentially reliable hydrogen energy systems, including fuel cells,
- Availability of the renewable resources and utilization of renewable energy resources,
- Use of cleaner technologies for production, transportation, distribution, storage and use,
- A reasonable supply of financing and proficiently viable incentives,
- Academia, industry and government partnership programs,
- Policy development for sustainable energy programs and spreading them within people,
- Appropriate monitoring of the technology and evaluation of various tools, and
- Road maps for future implementation so that people are aware about its applicability.

A sustainably high quality of life is the basic requirement for giving a clean, safe, reliable and secure energy supply in any of the country. To promise a competitive economic environment, energy systems must meet the following societal needs at affordable economic price:

1. Climate change must be taken into consideration;
2. Reducing the toxic pollutants; and
3. Planning for diminishing the reserves of oil.

Failure to reach these above desirable scales, we may have the negative impacts on:

1. Economy values;
2. Our environment; and
3. Public health, which is major issue in the whole universe.

Therefore some measures are needed to be taken:

1. Energy should be used more efficiently; and
2. Carbon free sources.

3. Key Factors and Criteria That Are Essential For Sustainable Development

There are many factors related to sustainable development with respect to fuel cell technologies. Out of the above factors some of them are explained as follows:

1. **Public Awareness:** Public awareness and public benefit campaigns constitute an important element to support energy conservation and energy efficiency promotion policies and programmes. Energy production and use, in particular energy production based on fossil fuels, as well as electricity production and use based on nuclear energy, causes emissions that can be harmful to the environment and to human health. In addition to concerns over local, national, regional as well as trans-boundary air pollution, growing concerns over climate change and its possible negative impacts have motivated energy saving, energy conservation and energy efficiency promotion policies in many countries. Each country faces different challenges when it comes to the provision of energy for sustainable development. Energy and energy efficiency policy approaches as well as regulatory frameworks vary from country to country as do public benefit campaign concepts. The public must be aware for such sustainable and efficient systems.
2. **Sustainability education and training:** Adjustments within the education system should convince teachers and students to learn for the sake of their future and to immerse themselves in a culture of complexity. Critical thinking should bring them to question their existing values and reflect upon their own learning.
3. **Energy strategies for better efficiency:** When energy consumption is in a planned way. There are several strategies developed by countries like US, UK and Germany.
4. **Promoting environmentally benign technologies:** The environmentally clean, quiet, flexible to sustainability and lesser reduction technologies should be promoted in order to have the long term power supply systems.
5. **Development of sustainable hydrogen economy infrastructure:** The hydrogen transitions will not need ample amount of investments in addition to those already ongoing industrial systems.
6. **Reliable hydrogen energy systems:** The hydrogen fuel cell technology is promising and reliable energy systems in terms of non-polluting, energy efficient, renewable energy resources. An inexpensive and stable energy supply is a prerequisite for sustainable development.
7. **Availability and utilization of renewable energy resources**
8. **Use of cleaner technologies**
9. **Supply of financing and incentives**
10. **Government partnership programs:** most public awareness and public benefit campaigns are designed and implemented by government agencies or by concerned non-governmental or civil society groups. In many cases, campaigns are supported by volunteers. In some countries, private companies also support public energy efficiency awareness campaigns and/or the dissemination of their messages.
11. **Appropriate monitoring and evaluation tools**
12. **Future implementation:** In near future, the technologies like fuel cell are sustaining, renewable and clean technology will to power house hold devices, vehicles and portable equipments.

4. Sustainable development and thermodynamics

Exergy, sustainable development and energy are correlated with each other. Hence, understanding thermodynamics concepts is very much important to govern these energy systems sustainably. Exergy is a thermodynamic concept, used for many years within engineering analyses of chemical and Mechanical processes and systems. It is defined as

$$\text{Energy Efficiency: } \eta = \frac{\text{energy in products output}}{\text{energy in inputs}} = 1 - \frac{\text{energy loss}}{\text{energy in inputs}}$$

$$\text{Exergy Efficiency: } \Psi = \frac{\text{Exergy in products output}}{\text{Exergy in inputs}} = 1 - \frac{\text{Exergy loss} + \text{exergy consumptions}}{\text{Exergy in inputs}}$$

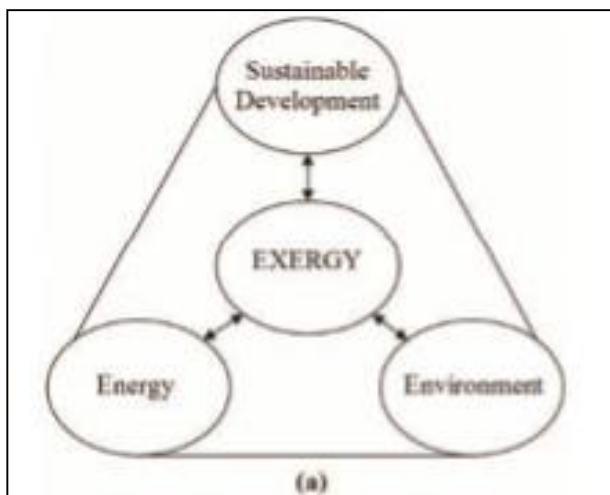


Fig 1a: The triangle of Exergy, Energy, Sustainable development, Energy and Environment.

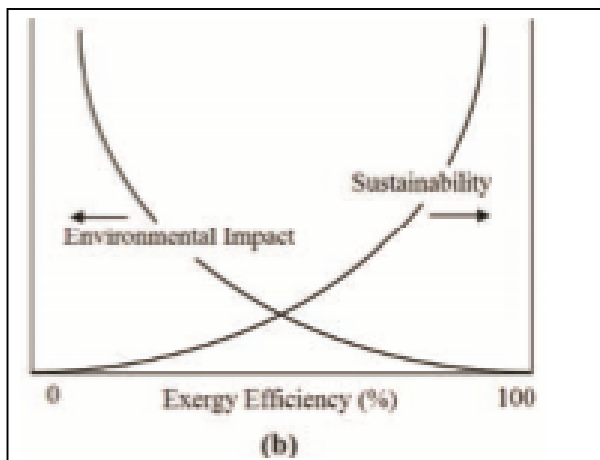


Fig 1b: The representation of Environmental impact, Sustainability of a process and Exergy Efficiency.

In the above, it can be seen that as exergy efficiency is reaching 100 %, the environmental impact is growing towards zero. The sustainability is reaching infinity because the process approaches reversibility. And when the exergy efficiency is reaching 0%, the sustainability approaching towards Zero environmental impact is growing towards infinity.

5. Fuel cells as hydrogen energy systems

Fuel cell technology are very clean, flexible and already been to such extent that these are effectively been used in many areas like space, portable devices and vehicle. We can produce hydrogen sustainably with exact null amount of carbon dioxide from renewable energy systems. Solar system

is the best example of it. The power system consisting hydrogen from renewable resources and fuel cell closed system, because none of the products are lost to the environments. The water consumed is converted to gases. The gases are converted back to water. The electrical energy produced is produced here and it is transferred to chemical energy in the gaseous state. The gases are reconverted back to electricity.



Fig 2: The key factors sustainable development under global sustainability

6. Hydrogen Safety

However, hydrogen gas has a few unique properties that require special consideration. For example, hydrogen can leak easily and ignite a relatively low temperature.

As with any fuel, safe handling depends on knowledge of its particular physical, chemical, and thermal properties and consideration of safe ways to accommodate those properties. Hydrogen, handled with this knowledge, is a safe fuel.

In many cases, hydrogen is safer than the fuel we currently use to power our cars. Carbon-based fuels tend to spread as liquids (as you well know if you've ever spilled gasoline on yourself at the pump). When it burns, conventional fuel produces hot ash, creating radiant heat. This isn't the case with hydrogen. In its pure form, hydrogen burns no carbon and produces no hot ash and very little radiant heat. The problems can be minimized with proper equipment design and operating procedures, however, and are generally agreed to be of less concern than hydrogen's flammability.

7. Myths about hydrogen

The following are myths about hydrogen:

1. Hydrogen infrastructure will be prohibitively expensive. There is no such need for investments as it is in present existing scenario.
2. Hydrogen fuel cells are too expensive. It is as simple as there is an evolution of new technology the cost can be an issue. But as demand increase the scientists and engineers make newer inventions for the cost effective product.
3. Hydrogen cost is a myth for many. Even at the present price of delivered liquid hydrogen, if you used hydrogen to power a fuel cell vehicle, your cost per kilometre would be the same as getting gasoline for a dollar a gallon.
4. The costs of fuel cells will inevitably decrease because the raw materials (such as graphite, commodity metals, plastics, and composite) are inexpensive. The only material that is expensive is current catalyst, typically platinum. To overcome this, scientists are researching alternative catalysts from base metals and reducing the amount of platinum needed. Furthermore, platinum may become less expensive due to new platinum recycling systems. Despite their higher setup and development cost, fuel cells have lower maintenance costs and longer operating life.
5. For vehicles, according to well-to-wheels studies, hydrogen fuel cell vehicles are at least twice as efficient as gasoline vehicles, and 40% more efficient than a hybrid. Most hydrogen internal combustion engines are about 30% more efficient than their gasoline counterparts and fuel cells are 100-200% (2-3 times) more efficient.

Conclusion

The benefits of hydrogen and fuel cell systems are described using the thermodynamics principle. Assessments of the sustainability of processes and systems, and efforts to improve sustainability, should be based in part upon thermodynamic principles, and especially the insights revealed through exergy analysis. For societies to attain or try to attain sustainable development, effort should be devoted to developing hydrogen and fuel cell technologies. Renewable energy utilization in hydrogen production can provide a potential solution to current environmental problems.

Acknowledgment

The author would like to thank Prof. Dr. Sarita Sharma for their inputs and guidance. Author was grateful to gain knowledge from such an accomplished individuals.

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