

## GLOBAL HYDROGEN BANK\*

Münci ÇAKMAK\*\*

Hilal ALBAL\*\*\*

### ABSTRACT

*Hydrogen energy, as a clean energy resource, is the princess of the other energy resources. It never pollutes or even empsons our Earth. Although it has great advantages for our Earth, hydrogen energy needs high technology, fund and incentives to be economical. Production and storage methods of the hydrogen are not economical today as it needs expensive high technological methods. There is also a lack of awareness about hydrogen energy. To overcome these disadvantages; governments, firms, investors, researchers need funds. Global Hydrogen Bank may be a solution for this issue. Global Hydrogen Bank can be organized by governments at the international level with international treaties to provide funds, loans, technological advices, feasibility reports, guidance, incentives and promotions. Especially low-interest loans for investors and guidance services for firms about technology transfers and infrastructure components will be beneficial for hydrogen energy production. Selecting only hydrogen among other clean energy resources will provide specialization.*

**Keywords:** *Hydrogen, renewable energy, alternative energy, fuel cell, hydrogen energy*

### GLOBAL HİDROJEN BANKASI

### ÖZET

*Temiz enerji kaynağı olarak hidrojen enerjisi, diğer enerji kaynaklarının presensesi gibidir. Dünyamızı kirletmez veya zehirlemez. Dünyamız açısından önemli avantajlara sahip olmasına rağmen hidrojen enerjisi ekonomik olabilmek için yüksek teknoloji, sermaye ve teşviklere ihtiyaç duymaktadır. Hidrojenin üretim ve depolama yöntemleri pahalı yüksek teknolojiler gerektirdiğinden bugün için ekonomik değildir. Ayrıca hidrojen enerjisi ile ilgili farkındalık yeterli seviyede değildir. Bu dezavantajların üstesinden gelebilmek için hükümetler, şirketler, yatırımcılar ve*

\* Bu çalışma 28-31 Ağustos 2016 tarihleri arasında İstanbul'da düzenlenen IV. European Conference on Renewable Energy Systems – ECRES 2016 isimli konferansta poster olarak sunulmuştur.

\*\* Doç. Dr., Gazi Üniversitesi Hukuk Fakültesi İdare Hukuku Anabilim Dalı Öğretim Üyesi, e-posta: munci@gazi.edu.tr.

\*\*\* Arş. Gör., Gazi Üniversitesi Hukuk Fakültesi İdare Hukuku Anabilim Dalı, e-posta: hilal.albal@gmail.com.

**Yayın Kuruluna Ulaştığı Tarih** : 31/05/2017

**Yayınlanmasının Uygun Görüldüğü Tarih:** 27/09/2017

*araştırmacıların sermayeye gereksinimi vardır. Global Hidrojen Bankası bu soruna bir çözüm niteliğindedir. Global Hidrojen Bankası, devletler tarafından uluslararası düzeyde anlaşmalarla kurularak sermaye, kredi, teknolojik danışmanlık, fizibilite raporları, rehberlik, destek ve teşvikler sağlamalıdır. Özellikle yatırımcılara düşük faizli krediler verilmesi ve şirketlere teknoloji transferi ve altyapı malzemeleri konusunda rehberlik hizmetlerinin sunulması hidrojen enerjisi üretimine yararlar sağlayacaktır. Diğer temiz enerji kaynakları arasından sadece hidrojenin seçilmesi ise uzmanlaşmayı sağlamak amacıyla.*

**Anahtar Kelimeler:** Hidrojen, yenilenebilir enerji, alternatif enerji, yakıt hücresi, hidrojen enerjisi

## INTRODUCTION

Environmental problems and limited structure of fossil fuels make us to prefer clean and free renewable energy resources. The global climate change demands a new era of clean, safe and sustainable energy supply.<sup>1</sup> In order to save our world with clean and sustainable energy, we have to choose renewable energy systems like solar, wind, hydrogen and wave/tidal/ocean energy.

Petersen & Andersen point that there are four overarching problems or policy objectives are consistently understood as providing the basic reasons and underlying drivers for a hydrogen future; these are climate change and the need to reduce carbon dioxide emissions; energy security, local air quality and competitiveness.<sup>2</sup>

Hydrogen is the lightest, the simplest, and one of the most abundant elements in nature.<sup>3</sup> It is non-toxic, “clean, not harmful to the environment or life, renewable, securely storable and transportable, broadly utilizable in various applications, producible by different techniques and from various sources, and

<sup>1</sup> Conte, M., Iacobazzi, A., Ronchetti, M., and Vellone, R., “Hydrogen economy for a sustainable development: State-of-the-art and technological perspectives”, *Journal of Power Sources*, 100, (2001), s. 186.

<sup>2</sup> Petersen, L.K., and Andersen, A.H., “Socio-cultural barriers to the development of a sustainable energy system – the case of hydrogen”, *National Environmental Research Institute, Aarhus University*, 34 pp., Research Notes from NERI No. 248 <http://www.dmu.dk/Pub/AR248.pdf>, (2009), s. 9.

<sup>3</sup> Conte, M. et al., 2001, s. 173.

economically usable” energy carrier.<sup>4</sup> Although it has these advantages, as a fuel and energy carrier, hydrogen has several problems in developing the required technologies for the production, transportation, storage, utilisation.<sup>5</sup> As a result, hydrogen has not been perceived by the individual consumer yet.<sup>6</sup> In order to develop hydrogen and fuel cell technologies, “an integrated set of activities should be conducted including research and development, technology assessment, standards development and technology transfer.”<sup>7</sup>

There are some significant barriers to hydrogen energy production and consumption. Our aim is to give an idea for hydrogen utilization development, considering economical perspective of hydrogen market, by offering a bank model named Global Hydrogen Bank.

### **A. BARRIERS TO HYDROGEN ENERGY**

There are three common barrier to hydrogen energy; cost, technology and lack of information. These issues are connected to each other. Increasing knowledge and information will inform interest to research and development; research and development will raise technological advance, technological advance will affect cost of hydrogen utilization. Generally, as it is seen this chain reaction, high technology and cost issues are the main disadvantages of hydrogen energy but we should never forget that there will likely be an extended period of time when the new technologies consume more energy than they produce.<sup>8</sup> We should not exclude hydrogen energy because of its expensiveness. “Accomplishing the cost and technology issues are compulsory for recognizing the fuel cells and other hydrogen technologies by the masses.”<sup>9</sup> In the future it will be cheap to produce hydrogen energy. The target of Global Hydrogen Bank must be challenging with these factors which create barrier to hydrogen energy.

---

<sup>4</sup> Rusu, I., Cautis, F., Hutanu-Alexoaie, G., Strugaru, M.F., and Stan, N., “Politics and hydrogen energy”, *European Journal of Science and Theology*, Vol.8, Supplement 1, June (2012), s. 213.

<sup>5</sup> Conte, M. et al., 2001, s. 173.

<sup>6</sup> Rusu, I. et al., 2012, s. 214.

<sup>7</sup> Dincer, I., “Hydrogen and fuel cell technologies for sustainable future”, *Jordan Journal of Mechanical and Industrial Engineering*, Volume 2, Number 1, (2008), s. 13.

<sup>8</sup> Turner, J.A., et al., “Sustainable hydrogen production”, *Science*, 305, (2004), s. 973.

<sup>9</sup> Dinçer, M.Z., and Aslan, Ö., “Sürdürülebilir Kalkınma, Yenilenebilir Enerji Kaynakları ve Hidrojen Enerjisi: Türkiye Değerlendirmesi”, *İstanbul Ticaret Odası Yayınları*, No:2009/51, İstanbul (2008), s. 113.

## 1. Cost

Cost is the principal barrier to investment in hydrogen because of this hydrogen is still far from being competitive in most applications; “the cost of supplying hydrogen energy using current technologies, is still very high compared to conventional energy technologies.”<sup>10</sup> “Hydrogen is currently more expensive than other fuel options, so it is likely to play a major role in the economy only in the long term, if technology improvements succeed in bringing down costs.”<sup>11</sup>

## 2. Technology

In hydrogen economy; high technology must be developed for production, storage, transportation and consuming of hydrogen.<sup>12</sup> As hydrogen energy requires high technology at every level, this necessity make us to consider two important issues, technology and technology transfer. Technology can be defined as “anything, tangible or intangible, that could contribute to the economic, industrial, or cultural development of a country, whether or not that technology is presently available to the country.”<sup>13</sup> As we see, technology does not mean only devices and instruments, it also involves economical and cultural values. Technology transfer is exchanging of information between those that have it and those that do not<sup>14</sup>; but Haug remarks an important point of technology transfer, according to Haug, “to be a true transfer technology, there must be effective absorption of the transferred technology by the recipient country.”<sup>15</sup> This is very important for countries (including government, firms, investors) because importing only the infrastructures, devices and mechanical instruments is not enough for technology transfer. Recipient country must internalize and integrate with that transferred technology. Technology transfer

---

<sup>10</sup> UNEP, *The Hydrogen Economy – A non-technical review*, *United Nations Environment Programme*, (2006), s. 9.

<sup>11</sup> Dincer, 2008, s. 8.

<sup>12</sup> Dinçer/Aslan, 2008, s. 111.

<sup>13</sup> Haug, D.M., “The International transfer of technology: Lessons that east Europe can learn from the failed third world experience”, *Harvard Journal of Law & Technology*, Vol.5, Spring, (1992), s. 211.

<sup>14</sup> Hoekman, B.M., Maskus, K.E., and Saggi, K., “Transfer of technology to developing countries: unilateral and multilateral policy options”, *Research Program on Political and Economic Change*, Working Paper PEC2004-0003, *Institute of Behavioral Science*, (2004), s. 4.

<sup>15</sup> Haug, 1992, s. 211-212.

is also supported at international level. For example the Rio Declaration on Environment and Development (UN Conference on Environment and Development –UNCED - Rio de Janeiro, 1992), declares that “States should cooperate ... by enhancing the development, adaptation, diffusion and transfer of technologies, including new and innovative technologies.”<sup>16</sup>

It is a great chance for us that nearly all of the countries want to support renewable energy sources (and surely hydrogen) for some reasons. They have no unfavorable views on renewable energy, contrarily they are supporting renewable energy sources and regulate their political opinions according to clean energy systems by supporting renewable energy utilizations with incentives, promotions and education. This shows that future energy system based on hydrogen and electricity only requires technology, not political access.<sup>17</sup> Our only opponent is underdeveloped technology.

Standardization is also as important as technology because without standard, technology can not be effective; international technology can not be set up without international standards.<sup>18</sup>

These issues show us hydrogen energy has a close relationship with technology, technology transfer and standardization. Global Hydrogen Bank must support technological development and technology transfer by its economical instruments.

### **3. Lack of information**

Public opinion does not have enough information about hydrogen, so this is preventing the development of the hydrogen energy systems.<sup>19</sup> In most cases people, governments and investors have not enough information about hydrogen energy. There are some arguments that make hydrogen energy unpopular. Because of its expensive feature and high technology need, hydrogen energy production can not gain popularity like solar power and wind energy. Investors do not prefer hydrogen energy as they have not enough market information and lack of guidance.

---

<sup>16</sup> Technology Transfer: The Seven “C”s for the Successful Transfer and Uptake of Environmentally Sound Technologies, International Environmental Technology Centre, *United Nations Environment Programme*, Osaka, Japan, November (2003), s. 1.

<sup>17</sup> Crabtree, G.W., Dresselhaus, M.S., and Buchanan, M.V., “The hydrogen economy”, *Physics Today*, American Institute of Physics, December, (2004), s. 39.

<sup>18</sup> Dinçer/Aslan, 2008, s. 114.

<sup>19</sup> Dinçer/Aslan, 2008, s. 160.

Most likely, information processes will not enough for hydrogen market development so information and guidance actions must include convincing elements. Not only investors but also consumers must be convinced that hydrogen is economical, practical and safe.<sup>20</sup> The rise of the demands coming from convinced consumers will activate the hydrogen market, so this will engage attention of investors. Global Hydrogen Bank will also inform consumers with different kind of programmes. Informing only investors is not enough for market development.

## **B. FUNCTIONS AND DUTIES OF THE GLOBAL HYDROGEN BANK**

“No private firm will invest in a commercial hydrogen venture unless it believes that it will be able to compete against existing fuels and turn a profit.”<sup>21</sup> The transition to a hydrogen economy should be encouraged, and developed countries, in particular but not only, should increase investments in hydrogen energy.<sup>22</sup> Government incentives promote hydrogen energy and other renewable energy utilizations but that is not enough for global hydrogen market deployment. Also incentives are not same in all countries, or even some of them have no incentives for hydrogen energy. Underdeveloped countries are another problem. “The emphasis of the hydrogen research agenda varies with country; communication and cooperation to share research plans and results are essential.”<sup>23</sup> So we have to consider the importance of community and participation. Conte et al. specifies that “the joint effort of major stakeholders (research organizations, industry, international bodies, association, standard setting bodies) at national and international level will be essential for an early development and diffusion of hydrogen as a fuel and energy carrier by means of a world-wide network of expertise, knowledge and products.”<sup>24</sup> Crabtree et al. also point that “cooperation among nations to leverage resources and create innovative technical and organizational approaches to the hydrogen economy is likely to significantly enhance the effectiveness of any nation that would otherwise act alone.”<sup>25</sup>

---

<sup>20</sup> UNEP, 2006, s. 10.

<sup>21</sup> UNEP, 2006, s. 21.

<sup>22</sup> Rusu et al., 2012, s. 213.

<sup>23</sup> Crabtree et al., 2004, s. 44.

<sup>24</sup> Conte et al., 2001, s. 186.

<sup>25</sup> Crabtree et al., 2004, s. 44.

Global Hydrogen Bank can be solution for globalization need of hydrogen economy as mentioned above. As Global Hydrogen Bank will be an international bank; everyone will get benefit from this feature. Investors, governments, consumers and markets will find a safe, consistent and profitable area at an international level. Banks are the institutions which help providing macroeconomic consistence in the long period.<sup>26</sup> So, Global Hydrogen Bank will affect macroeconomic balances between energy markets, provide consistency, protect especially investors from crisis and price fluctuations.

Primary aim of the Global Hydrogen Bank must be “To operate global hydrogen market” across the world because the ultimate success of a hydrogen economy depends on how the markets react.<sup>27</sup> To achieve this target, Bank should give importance to economical/low-interest loans for firms and component trade.

Global Hydrogen Bank should be founded by international agreement/treaty by countries. Every country should have a share on capital. Countries may get profit at the end of the year. These profits may be either in capital, promotion or infrastructure component. The benefits which will come from Global Hydrogen Bank should be distributed in countries by governments. Governments play a key role in the move from fossil-fuel to hydrogen technology,<sup>28</sup> benefits must turn into governmental incentives and promotions at national level.

Functions of the Global Hydrogen Bank must be:

- providing loans for firms and countries,
- providing cheap infrastructure components for investors,
- helping governments for hydrogen targets,
- providing information for governments, investors and public about hydrogen energy and economy,
- educating everybody about hydrogen energy by organizing symposiums, conferences, courses,

---

<sup>26</sup> Yetiz, F., “Bankacılığı doğuşu ve Türk bankacılık sistemi”, *Niğde Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi*, Nisan 9(2), (2016), s. 107.

<sup>27</sup> Crabtree et al., 2004, s. 43.

<sup>28</sup> Crabtree et al., 2004, s. 43.

- making connections between investors, countries and international/national markets,
- encouraging firms for hydrogen investments,
- guiding technology transfers between investors and countries,
- giving purchase guarantees,
- setting up a hydrogen credit system for the trade of hydrogen and infrastructure components,
- enriching the global hydrogen market and national hydrogen markets.

### **CONCLUSION**

If we want to place hydrogen energy in our daily life like fossil fuels, we (countries, national and international firms and persons) have to come together and act in coordination. Global Hydrogen Bank can be a way/solution to achieve this coordination. Development of hydrogen energy depends on the stimulation of the active market. In order to stimulate market we have to encourage investors and governments. Investors need safe and consistent markets, economical loans and incentives. Global Hydrogen Bank must take care of the investors and market.

There are some organizations/associations/partnerships which in action both international and regional level such as European Hydrogen and Fuel Cell Association (EHA), International Association for Hydrogen Energy (IAHE), Hydrogen, fuel cells and electro-mobility in European Regions (HyEr), Fuel Cells and Hydrogen Joint Undertaking (FCH), Hydrogen Europe, International Partnership for Hydrogen and Fuel Cells in the Economy (IPHE), International Energy Agency (IEA) and International Renewable Energy Agency (IRENA), who play active roles in R&D, commercialization, education, awareness and coordination.<sup>29</sup> We can place Global Hydrogen Bank among these organizations as an economic pioneer and market director.

---

<sup>29</sup> UNEP, 2006, s. 38.



## REFERENCES

- Conte, M., Iacobazzi, A., Ronchetti, M., and Vellone, R.**, “Hydrogen economy for a sustainable development: State-of-the-art and technological perspectives”, *Journal of Power Sources*, 100, 171-187 (2001).
- Crabtree, G.W., Dresselhaus, M.S., and Buchanan, M.V.**, “The hydrogen economy”, *Physics Today*, American Institute of Physics, December, 39-44 (2004).
- Dincer, I.**, “Hydrogen and fuel cell technologies for sustainable future”, *Jordan Journal of Mechanical and Industrial Engineering*, Volume 2, Number 1, 1-14 (2008).
- Dinçer, M.Z., and Aslan, Ö.**, “Sürdürülebilir Kalkınma, Yenilenebilir Enerji Kaynakları ve Hidrojen Enerjisi: Türkiye Değerlendirmesi”, *İstanbul Ticaret Odası Yayınları*, No:2009/51, İstanbul (2008).
- Haug, D.M.**, “The International transfer of technology: Lessons that east Europe can learn from the failed third world experience”, *Harvard Journal of Law & Technology*, Vol.5, Spring, 209-240 (1992).
- Hoekman, B.M., Maskus, K.E., and Saggi, K.**, “Transfer of technology to developing countries: unilateral and multilateral policy options”, Research Program on Political and Economic Change, Working Paper PEC2004-0003, *Institute of Behavioral Science*, (2004).
- Petersen, L.K., and Andersen, A.H.**, “Socio-cultural barriers to the development of a sustainable energy system – the case of hydrogen”, *National Environmental Research Institute, Aarhus University*, 34 pp., Research Notes from NERI No. 248 <http://www.dmu.dk/Pub/AR248.pdf>, (2009).
- Rusu, I., Cautis, F., Hutanu-Alexoaie, G., Strugaru, M.F., and Stan, N.**, “Politics and hydrogen energy”, *European Journal of Science and Theology*, Vol.8, Supplement 1, 211-221, June (2012).
- Technology Transfer: The Seven “C”s for the Successful Transfer and Uptake of Environmentally Sound Technologies**, International Environmental

Technology Centre, *United Nations Environment Programme*, Osaka, Japan, November (2003).

**Turner, J.A., et al.**, “Sustainable hydrogen production”, *Science*, 305, 972-974 (2004).

**UNEP**, The Hydrogen Economy – A non-technical review, *United Nations Environment Programme*, (2006).

**Yetiz, F.**, “Bankacılıđı doğuşu ve Türk bankacılık sistemi”, *Niğde Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi*, Nisan 9(2), 107-117 (2016).