

The future of bioenergy as a component of smart cities

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Abstract

A thematic in vogue nowadays is bioenergy evolution as a solution for sustainable development, certain global conflicts, etc. Undeniably, bioenergy represents future energy as a component of smart city development. The main problem today is that resources used to obtain energy are limited, non-renewable and unequal distributed on the planet but the energy consumption is growing. Humanity has to find other sources of energy besides oil, coals and gas. There are two directions: nuclear energy and bioenergy. The second option is preferred to be developed for security reasons. The problem in obtaining bioenergy is that storage methods are not efficient for the moment and its production is not equally distributed for the entire period of the year in most states. The purpose of this article is to analyze the future perspective about the strategic resources in the global context where the most important factors are: political environment, usability, price vectors, technologies, and sustainable development.

Keywords: *smart city, bioenergy, strategic resources.*

1. Introduction

The importance of energetical resources is so accentuated due to unequal distribution combined with the energy needs of our society. Thus, there are a lot of diplomatic and military conflicts aroused all around the world because of them. For example UE vs. Russia (diplomatic conflicts for gas), Iraq vs. Kuwait (military conflict for oil) etc. On the other hand, in opposition to the conflicted attitude, states

often are integrated into strategic alliances made for better access to resources. This subject can be approached through certain perspectives.

Firstly, considering the environmental impact of fuels that generate a lot of pollution affecting human health, the next generations and a lot of animal species. Politics is another factor that can easily change the direction of energy evolution. The main reason is that there will be always a battle between states for power and influence. Moreover, a resource is called “strategic” when it is a part of certain strategies that a state wants to apply on the global stage. The technological is shaping up a frame for bioenergy development. The rentability of bioenergy projects depends on the research advance.

The first section will analyze the past and the present in order to understand how the future of bioenergy can be developed as a part of the smart cities concept in contrast with the old sources of energy as fuels. In the beginning, will be defined all the topics relevant to bioenergy. Also, the topic of conflict will be addressed and the alliances of the states.

The second section will contain the actual stage of energy development, pros, and cons for bioenergy and in the last section will be discussed the most important topic of the paper: the future perspective of smart cities through an energy view.

2. The past and the present of energy in a global perspective

Natural resources are defined as natural elements exploited by humans for achieving social welfare but just that resources that have a real impact on social and economic development, unequally distributed on the planet, could be called strategic resources.

Since the XX century, this category is represented by the next energy resources: oil, gas, radioactive metals. It is considered that the global resource for nowadays is the oil and gas is just a regional one even though, in the past, due to the industrial revolution, the most important source of energy was the coal. That period was the beginning of the energy domain supremacy in the economic global context. The atomic energy, besides the other forms of energy, is approached in a different way because of the risks involved. [1]

Global conflicts become atypic in the XXI century due to the technology advance and globalization. An atypic conflict represents a combination of different battle manners, conventionals or not including activities against international law as terrorism, organized crime, mass-media. These tools are used to create an impact on the political and economic environment.

Hybrid war is made by armed battle Through conventional and unconventional methods as manipulating the autochthon people for obtaining political influence in the conflictual area. In this way, the territorial conquest is eased. The political factor becomes complementary for the military one. For example, a separatist movement can be financed by a state which aims to send their armed forces in order to conquer the territory as it happened with the annexation of Crimea by Russian. [2]

Concomitant with military wars, in global politics, is looming economic strategies. Often, the political component comes first over the economic one. This fact is well shaped up in the Donbas conflict. The Russian strategy was to offer gas at a preferential price to the post-Soviet countries (among them Ukraine) exchange for some concession as giving up the aspirations for UE (European Union). Thus, economically this measure is a disservice for Russian but through a geostrategic view, it held back the advance of occidental frontiers in the East of Europe when the Russian goal is to consolidate its influence on the continent. [3]

Well-known are the Middle Eastern conflicts, the most strained zone in the world due to the oil reserves, 47% of the global reserves (Iran 9,3%, Irak 9%, Kuwait 5,9%, Saudi Arabia 15,6%) what prompted the involvement of more states in the local conflicts, states as the USA, Russian, Poland, France, UK etc. The Middle East states are the most imports important oil suppliers for the international market so the stake is big. The most important conflicts of the XX and XXI century were in these areas (The first oil crisis and The Arab-Israeli war from 1973, The second oil crisis from 1979, the war Iran-Iraq from 1980-1988, Iraq invasion of Kuwait from 1990-1991, the 2003 invasion of Iraq. [1]

The first and second oil crisis left behind an increased geostrategic interest of the occident aiming oil-producing countries. The crises make the states realize how important oil access is and also, the influence of global market prices resulted. After the first oil crisis, the USA lost the influence in Iran and Iraq damaging the trade relations based on oil. This impediment is easy to transform into an advantage for Russian. In this context, SUA was implied in the next wars where a key role was played by Saddam Hussein, ex-CIA agent. [3]

Geostrategic resources play an important role in the development of a state economy based on a hard to control dependency for energy. At this level, in international commerce shall be deducted strategic features that inhibit the free-trade notions. Therefore, trade, for some producing countries, is made under a strategic and political approach meant to function as declarations of power on the international plan. For other states that have to import energetical resources, the strategy is to obtain a good price and limitate the energy dependency, so they have to increase the number of countries that they import from. The main problem is that if you are energetically depending on one single state that exports to you the resources that you need, that state can blackmail you to make some compromises under the threat that you will not receive these resources anymore. It is a very important fact as long as it can be seen, on a large scale, that the most developed countries are the biggest consumers of energetic resources and the technology development that is vital nowadays is depending on the energy domain. Furthermore, a new supplier is hard to contract because these kinds of resources are concentrated in not many areas and there are not too many countries that export them. That is the feature that includes the trade with energetical resources in what it is named strategic trade through are made a lot of diplomatic conflicts and alliances. Examples of alliances are OPEC Organization of the (Petroleum Exporting Countries) and GECF(Gas Exporting Countries Forum) and another diplomatic

conflict can be considered the project NABUCCO with its challenge with Russian projects: Blue Stream, South Stream, and North Stream.

Nabucco was a 2004 Austrian project initiated by the USA in 1996 that aims to diversify the delivery routes and the suppliers resulting in economic rentability and energetical security. The start for Nabucco happened when Russian used the "gas tap" during the gas war. This movement symbolized the transition from "hard power" made through military pressure, to "soft power" made through energetical pressure, both of them being equally efficient. Thus, the Russian reaction when Ukraine and Georgia wanted to accede to the EU was to stop providing gas to them in the winters of 2006, 2008 and 2019. The problem was that the Ukraine and Georgia accession to UE means that they are getting out of the Russian influence in the East of Europe and It was a big wake-up call for UE concerning the risks of the future. [4]

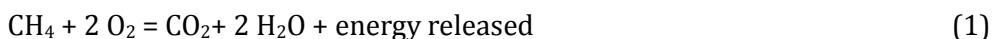
Blue stream was the first step made by Russian to give an alternative to Nabucco. It had a big success due to the very optimistic view of UE that considered that in the future the consumption of gas will increase so much so Blue Stream will remain just an alternative to Nabucco, the Nabucco route will be undoubtedly necessary for covering the consumption. Nowadays, Bluestream is finished and UE needs no more economically Nabucco. Now, a new route is efficient just strategically. The results were narrowing the Nabucco project and accentuating the dependency of the transit zone Turkey.

Nord Stream is another Russian project in competition with Nabucco. It was launched in 1997, has started in 2005 and is finished since 2011. Nord Stream is engineered for the direct distribution of gas to Germany. Nord Stream is the friendship result of the German chancellor Gerhard Schroeder and the Russian leader Vladimir Putin.

South Stream is the Russian version for gas supply in the South and the center of Europe. It started in 2012 and was ready for use in 2015.

Shall be observed that the difference is made by objectives. The European one was firstly economic and then strategic but the Russian objective is purely strategic. For the UE is not cost-effective to invest in strategic infrastructure. [5]

Bioenergy has more advantages compared with the old sources. One of them is about the ecologic domain. The pollution is one of the most debated subjects where pollution is discussed as being one of the most dangerous problems nowadays that can affect us and the next generations. Oil and gas consumption results in carbon dioxide, nitrogen oxide, sulfur dioxide, and other derivatives that are eliminated in the air and generate a high level of pollution. For example, when the principal chemic component of natural gas, methane, is burned, the equation (1) is happening:



Where:

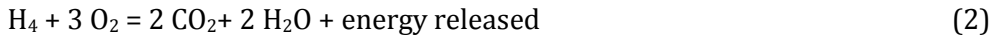
CH_4 = a methane molecule

2O_2 = two oxygen molecules

CO_2 = the molecule of carbon dioxide

$2 \text{H}_2\text{O}$ = two molecules of water

Liquefied natural gas has a double carbon concentration and ethane is the principal chemical component that substitutes the methane. Thus, liquefied natural gas pollutes twice as its gaseous form. It is due to an increased level of density. For the liquefied natural gas, the equation (2) is happening:



Where:

H₄= a hydrogen molecule

3 O₂ = three oxygen molecules

2 CO₂= two molecules of carbon dioxide

2 H₂O= two molecules of water

Oil represents a mixt between gaseous and liquid hydrocarbons and it is more pollutant then the natural gas. However, the amount of carbon dioxide emitted increases faster compared to the energy generated, which can further lead to an economic-ecological inefficiency in the use of hydrocarbons. Although carbon dioxide is not a toxic substance, due to the large amount that exists in the atmosphere, it generates climate change. It helps the atmosphere to absorb more heat and reflect less, which results in global warming.

Oil is a dense hydrocarbon and contains more impurities that react with other components and become harmful. Among the pollutants emitted by combustion are sulfur dioxide and nitrogen oxide. The two substances are the precursors of nitric acid and sulfuric acid, which are the main determinants of smog and acid rain. Acid rains, most of the time, have devastating effects on flora and fauna, even on the human body at direct contact. [6]

3. The future of energy resources -bioenergy

The geopolitical climate of strategic resources changes over time. As can be seen, resources have increased or decreased in importance depending on technological evolution. In the beginning, pastures and fertile soils were considered the most important resources, then steel and cast-iron. The interests have changed with the Industrial Revolution when the eyes were focused on coal, today oil is considered the most important global resource and it is certain that it won't remain forever.

Fossil fuels are present on Earth in limited quantities and have an unequal distribution across the globe which creates a dependency for some states and represents a significant advantage for others. In the last period, due to technological advancements, it is tried to limit the dependencies by accessing other more accessible forms of energy that can offer favorable perspectives in terms of energy security. [7]

As history has shown, the transit to a new type of energy used by the masses is relatively slow, gradually. For example, approximately 100 years were needed to increase the global demand for coal from 10% to 60%. In the case of oil, from its introduction on the market until reaching a global quota of 50%, it has passed about 60 years.

The world tends to green energy. There are multiple reasons. Global warming and the current level of pollution raise concerns that cause states and international

organizations to encourage the research, development, and implementation of the technology required to obtain bioenergy.

From another perspective, green energy comes from various sources, mostly free (wind, solar, hydro) or easily accessible sources (ethanol obtained from various plants such as sugar cane). Thus, by using it massively, many states will become energy independent. At the same time, although the current technology for obtaining and storing it, is relatively expensive in the long term, it is much more profitable, especially because the environmental costs are minimal. [8]

US President Barack Obama said in one of his speeches that the nation that will rule the world will be the nation that will be the leader in the production of bioenergy, adding that the US will have to be that nation. Geopolitical, green energy will become that resource fairly distributed across the globe, accessible and free of charge, will change the global climate leaving the period of oil glory somewhere in history. Those who master the technology and use it at high capacity will gain a significant competitive advantage over the other states. [9]

The speech of the US President is complemented by the evolution of international investments. For example, in 2004 they totaled \$ 36 billion, growing at a rapid pace and reaching in 2010 to \$ 145 billion. [10]

The transition to the new energy era depends on cooperation between states from several perspectives:

- Intellectual property rights over clean energy technological innovations,
- Redirecting capital flows to research, development, and implementation of green energy,
- Limited access to the necessary supplies,
- Increasing the importance of bioenergy in international diplomacy.

The declining price of the technology used determines the accessibility that was missing from the new type of energy. However, for the technological advancement of a state in the biofield, states must focus more on long-term support, and also the capital market. [11]

There are already forms of geopolitical uses of it. For example, in countries from the Russian sphere of influence, Eastern Europe (Belarus, Bulgaria, Poland), green energy is used as a barrier to the Russian gas monopoly. The more they make their presence on the market (the power of the wind and ethanol extracted from the biomass used), the more the natural Russian gas loses its importance.

It can be seen new interstate relations and connections between regions. For example, France's effort known as the "Mediterranean solar plan", which consists of concentrating solar hubs in North Africa in order to improve energy security for countries such as Jordan and Morocco but also for European countries that will benefit from solar energy exports of Africa. Another example of collaboration is the strategic alliance between the US and China to manage solar power hubs in Abu Dhabi and solar charging bases in Iran. [8]

With biofuels already in use and electric cars put into circulation, oil is losing importance. On the other side, investments in ethanol have begun to form as a competition for OPEC member countries.

Green energy has succeeded in shadowing even the investments in nuclear energy which, although considered a non-polluting approach, is also a dangerous variant for international security. Due to uranium, the chemical element used to obtain nuclear energy is used in the manufacture of bombs and the technology is similar, this alternative is not well seen. Although it is a cheap form of energy, following World War II it proved to be dangerous enough to be unable to compete with oil today.

Thus, the impact of green energy in geopolitics is materialized by:

- Balancing regional powers,
- Modification of the international account,
- Outlining new strategic relationships.

Although the methods of producing renewable energy that will be used to replace today's fuels are not too accessible. They have a significant disadvantage that slowed down their use rate, such as the lack of an easy storage method for large quantities, there is no possibility of being constantly obtained, natural phenomena not being constant and predictable in the long term.

For example, energy can only be taken from the sun during the day, but it is also necessary at night. The energy that can be taken up during the day is often excess and can cover the need at night but a storage technology is required with a very large capacity. The greater the storage capacity, the longer the energy taken can be stored, distributed to more consumers, offers more security. [12]

The viable technology at the moment is the invention of the physicist Nicola Tesla: the lithium-ion battery. Although not a 21st-century invention, its mass use has been avoided due to high manufacturing costs. The technology has been improved and costs have decreased significantly in the last years (for example more than 14% only between 2007 and 2014 for lithium-ion batteries) becoming sufficiently accessible so that the storage and use of bioenergy become competitive with fuels energy. Significant price drops are expected due to technological advancement and mass production that will start in 2020. In figure 1 can be observed a parallel between cost estimated and demand estimation. [13]

Batteries work through a number of electrochemical cells that use their chemical property to store energy and convert it into electricity. For large batteries used in green energy storage, low-temperature lithium-ion batteries are used.

Lithium-ion batteries are also used for: mobile phones, laptops, but also electric cars, the efficiency of lithium in battery composition being up to three times higher than for other elements. Lithium is used as a medication, too.

Electric cars with lithium-ion batteries are more efficient, less polluting, less loud, accelerate faster and you have to invest less than those running on fuels. Lithium gives the battery, compared to other chemical elements, advantageous properties such as:

- Higher storage capacity for less substance (which reduces battery size),
- Higher power,
- High density due to the energy content of the battery cell,
- Longer battery life, aging, and degradation are slower,

- Maturity and Safety at the battery cell level,
- High supply capacity,
- Favorable loading/unloading characteristics,
- Efficiency in cycling and self-unloading,
- Low cost of batteries and materials,
- Lithium-ion batteries (like other batteries) can be recycled. [13]

The US-initiated project in Nevada "Tesla's Gigafactory" aims to propel the US state to the first position in Tesla battery production. It started operating in 2017 but will operate at a maximum capacity of 35 GWh of batteries per year starting in 2020. Due to this project, the US will exceed the current global total production. [7]

Currently, the states that are most encouraging the use of Tesla batteries for bioenergy storage are China, Germany, Japan, and the USA. These states are also noted for their support programs for citizens:

In Germany, 30% of the installations costs used in the individual production of bioenergy are subsidized, while Japan subsidizes with over 50% of the costs with the lithium-ion battery installations.

Programs for the implementation of green energy storage systems are being developed in states such as Hawaii, New York, Texas. China is noticed as the largest storage capacity regarding the hydraulic pump. California is the state that aims to make 33% of energy green in 2020 and 50% in 2030, performance supported by support programs. [13]

Australia is expected to be one of the largest markets. Currently, 15% of the houses on the territory of the state use solar installations and their number is increasing. The country has much solar potential and could be a strong exporter of solar energy in the region. Here energy is stored when the price is low and used or distributed when the price increases. A household uses about 80-60% of the energy stored. [10]

As a general remark, we can point out that the field of green energy stored with the lithium-ion battery has an increasingly advantageous character for global politics, environment and business environment. Profitability encourages private investments. Environmental and geopolitical factors encourage states to invest. [8]

The forecasts are the more favorable the more they are expected to make new discoveries regarding chemical reactions of lithium with other elements which would generate lower prices. Over time, humanity can reach the point where the use of oil as fuel is no longer profitable. In figure 2 it can be observed the price evolution of lithium-ion batteries materials.

In the graph above it can be seen that the price for lithium is relatively low compared to the chemical elements price. The technological advancement that leads to lower prices. It is a result of discovering new alloys that have an interaction similar to that of cobalt. Cobalt is a chemical element used initially and it is still used in bioenergy storage. Cobalt is much more expensive compared to the basic elements of the battery. [10]

The high level of technologization that the experts expect to increase in the next years will come with more than cheaper prices for energy, but also with new

methods to reduce consumption. With sensors help people will control it better through monitoring and making smart some functions as turning on/off the lights.

We can say that lithium will become the resource of the future, probably the most important because, without it, green energy cannot be stored in profitable conditions. Under this condition, Lithium can be the next global resource that can help our society to integrate better in the smart cities environment that will exist for sure in the future?

4. Conclusion

With the increasing importance of the energy field, the concept of energy security has been developed. This reflects the regional character of the geostrategic resources, which aims to reduce the dependence of the consuming states on the producing ones.

Energy investments are increasing in relation to the extent of resource use, the most favorable prospects are those of bioenergy which has registered significant increases in recent years. It is expected that the growth trend will be increasingly accentuated due to technological innovations in the bioenergy field. It will bring lower production costs and increased profitability. In my opinion, geostrategy of resources will continue to exist but of a smaller size as the resources used in the energy field will become increasingly accessible through the implementation of new technologies for obtaining and storing bioenergy.

As our society is based on bioenergy, it strengthens its position from year to year. Its importance could increase in the future. By adopting a new form of energy, some states, which have recently been neglected in global politics, will acquire strategic qualities and others will lose. Also, bioenergy, due to technological advancement and the ecologic dimension, will favorize the creation of smart cities where everything is high technologized following the concept of sustainable development.

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