Volume XXI 2018
ISSUE no.2
MBNA Publishing House Constanta 2018

Scientific Bulletin of Naval Academy

SBNA PAPER • OPEN ACCESS

The current state and the impact of the use of unconventional energies in the international energy context

To cite this article: Cristian NIȚĂ and Nicolae BUZBUCHI, Scientific Bulletin of Naval Academy, Vol. XXI 2018, pg. 39-51.

ISSN: 2392-8956; ISSN-L: 1454-864X

doi: 10.21279/1454-864X-18-I2-004

The current state and the impact of the use of unconventional energies in the international energy context

Cristian NIȚĂ, Nicolae BUZBUCHI
Constanta Maritime University, Constnta, Romania

Abstract. Approximately 90% of world commodity trade is made by shipping by shipping companies and, as such, shipping plays an important role in the modern world economy. Although there is not too much shipping capacity in relation to the size of shipping routes, ships are, owing to their high installed power, responsible for releasing impressive amounts of harmful gases and carbon dioxide emissions into the atmosphere, worldwide there is a continuing concern of specialists to find the appropriate ways to improve propulsion of ships, with the stated aim of making them as environmentally friendly, efficient and economical as possible.

1.International provisions on ship-source pollution and expected changes in the near future

In an increasingly globalized context, the amount of energy existing in some primary sources is also transformed into energy through irreversible phenomena, with predictable effects - the exploitation and consumption of fossil fuel reserves. Thus, saving energy, under any form of manifestation, seems to be imperative. However, the rise in living standards can not take place without a corresponding increase in energy consumption and hence the demand for energy is on the rise, which implies on the one hand the economy, on the other hand, the use of renewable energy resources.

Electricity is increasingly replacing other forms of energy because of the ease with which it is transported away and the possibility of turning it into other forms of useful energy such as: mechanical energy, light, heat, chemical energy. This has made electricity out of the total energy consumed over 30 percent today. The change from 2 kwh / day needed to ensure the living conditions of a man in a undeveloped society at 270 kwh / day as a man consumes a modern industrial society has the primary pollutant effect on the emission of substances with effect of greenhouse gas, in particular carbon dioxide.

The share of CO_2 emissions from maritime transport is 12.5% of total transport (7.5% air transport, 80% road transport and land traffic), which is a significant figure (Figure 1).

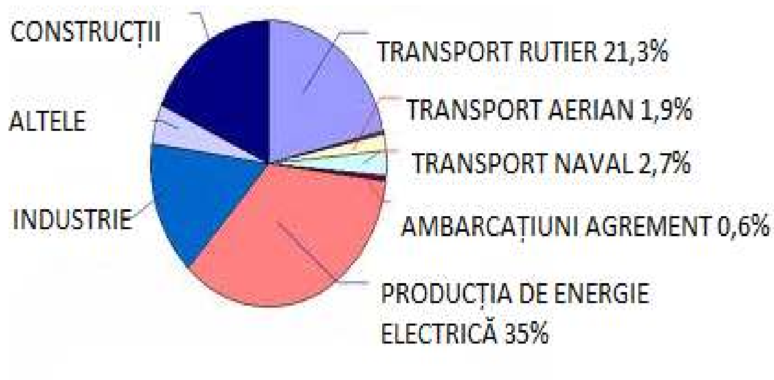

Fig. 1 The share of carbon dioxide in the atmosphere

In the naval field, technical progress and increasing demands for environmental protection have prompted the International Maritime Organization (IMO) to revise the rules on the prevention of air pollution by ships.

Thus, since 1997, the 1973 International Convention for the Prevention of Pollution from Ships, MARPOL 73/78 (abbreviation of "Marine Pollution"), has been added to the 1973 International Convention for the Prevention of Pollution from Ships annex, respectively Annex VI "Rules on the Prevention of Air Pollution by Ships" (implemented in our country by Law 269/2006).

As such, shipbuilders and shipbuilders and shipbuilders of the type covered by this international document, shipping companies, ship's crews, ship inspection, certification, and control authorities, and the other institutions with the role of State Authorities in the regulated field, the reduction of atmospheric pollution by combustion gases should be the primary objective in all their activities.

The revised Annex VI to MARPOL 73/78 contains rules on the control of emissions into the atmosphere from marine vessels, ie ozone-depleting substances, nitrogen oxides, sulfur oxides and particulates contained in exhaust gases - volatile organic compounds , as well as rules on the incineration of residues on board with regard to the operation of the receiving installations of certain categories of waste in ports, the quality of the fuels used by the ships, etc.

The main changes to the rules set out in Annex VI concern the progressive reduction in time of emissions of sulfur oxides emitted by engines used on ships by initially reducing the sulfur content of the fuels used, from 3.5% for January 1, 2012, at 0.5% as of 1 January 2020, if it turns out possible, on the basis of a study to be finalized by the IMO in 2018.

2.Global developments and challenges in the energy sector

Energy has become a strategic factor in global politics, a vital component and a cost factor for economic development and the progress of society as a whole, generating a number of major global concerns.

Given the limitation of primary energy resources, in order to achieve sustainability in this area, energy needs to be produced, delivered and consumed more effectively than before. Unless changes are made in energy production, transport and consumption, mankind may face a major energy crisis in the coming decades. If current energy laws and policies remain unchanged throughout the period up to 2035, global demand for energy will increase by almost 50% compared to 2007.

The largest share in energy consumption growth by 2035 will be 84% for countries outside the Organization for Economic Cooperation and Development (non-OECD countries) compared with only 14% for OECD countries.

Regarding electricity production, although the economic downturn slowed the growth rate of global electricity consumption in 2008 and 2009, it is estimated to increase from 18,800 TWh in 2007 to 35,200 TWh in 2035, an increase of 87% .

3.Energy Policy of the European Union

One of the major challenges for the European Union (EU) is how to ensure energy security with competitive and "clean" energy, taking into account the limitation of climate change, the escalation of global energy demand and the uncertain future of access to energy resources . The vision of today's European energy policy is in line with the concept of sustainable development and addresses the following important issues: access for consumers to affordable and stable energy sources, sustainable development of energy production, transport and consumption, security of energy supply and reduction of emissions of greenhouse gases.

The EU has developed an ambitious energy policy covering all sources of energy, from fossil fuels (crude oil, gas and coal) to nuclear and renewable energy (solar, wind, geothermal, hydroelectric, etc.) in an attempt to trigger a new industrial revolution that leads to a low-energy economy and limiting climate change, making sure that the energy we consume will be cleaner, safer, more competitive and sustainable. The EU energy policy for the period up to 2020 is based on three fundamental objectives, for which separate package of legislative and regulatory reform has been proposed, namely:

• Sustainability - highlights the EU's concern for climate change by reducing its greenhouse gas emissions

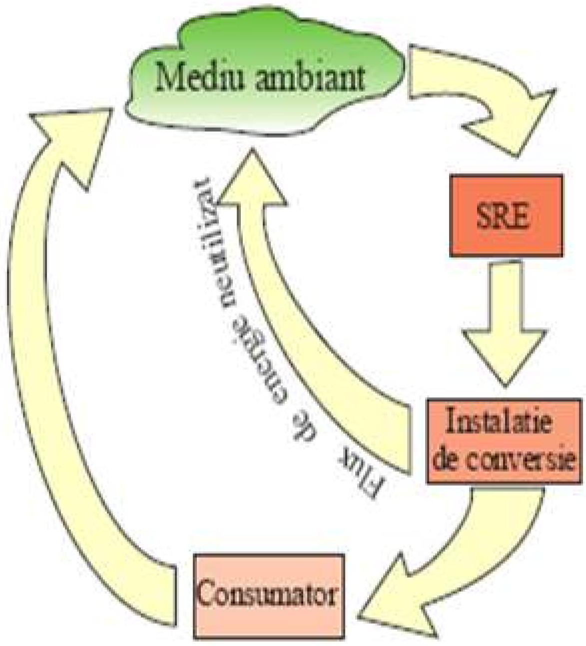

Fig. 2 Functional scheme of renewable energy transformations

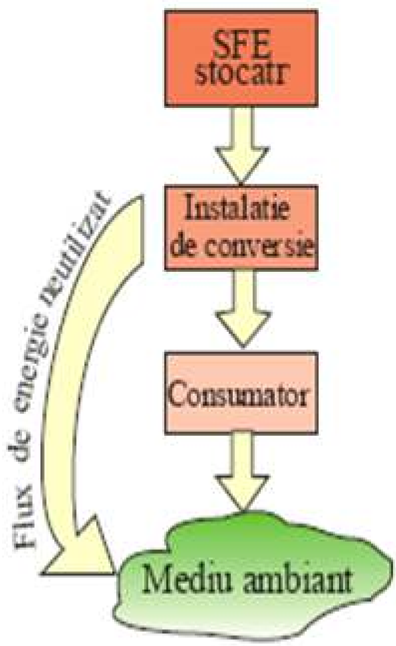

Fig. 3 Functional scheme of conventional energy transformation

There are a number of advantages and disadvantages of unconventional methods as follows:

Advantages of unconventional systems:

- does not pollute the atmosphere and the marine environment,
- are easy to install on board existing ships and do not require any noticeable alterations to the structure of the ship,

 increase the space for goods or passengers by reducing the space occupied by the car compartment (in the case of power-driven ships)

 the cylinders on which the photovoltaic cells are located are swinging and do not interfere with the operation of the ship in the ports,

 In the case of mixed propulsion engines, the fuel consumption decreases and the loss of speed is partly covered by the towing force of the raised ridge at a certain height.

Among the disadvantages of unconventional systems, we mention:

 Some systems can not be used in crowded areas with intense traffic,

 Shipowners' lack of confidence in these systems,

 use of unconventional systems only in certain navigation areas, with constant and constant winds in the direction and speed,

 The use of vertical cylinders (Flettner system) leads to increased metacentric height and in adverse weather conditions to the excessive inclination of the ship.

A classification of unconventional energy and energy conversion is shown in Figure 4.

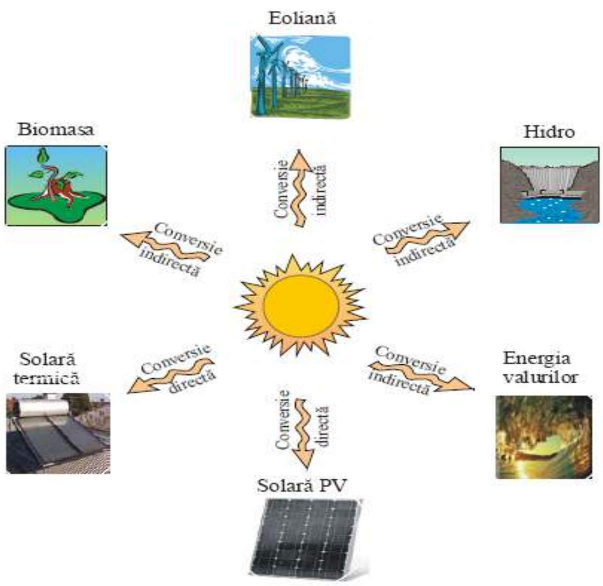

Figure 4. Forms of unconventional energies and types of conversions

Hydraulic energy

Hydraulic energy was the first form that man converted into other forms of energy, including electricity. The hydraulic power of the rivers has become a conventional form of potential energy storage of water and has great advantages in terms of its transformation. Other forms of unconventional energy (of waves, tides and sea currents) began to be of interest only with the outbreak of the energy crisis in 1972, although the preoccupations in this sense have existed since ancient times.

The hydraulic wave energy

The capture of the kinetic wave energy is a problem researched in many countries. However, the aggressiveness of the marine atmosphere and the irregularity of the waves have made it only in some areas of the world that capture facilities are effective. The first attempts date back to the 1920s, when M. Fusenot experimented in the Mediterranean Sea, near the Algerian coast, a device that managed to transform the direct wave motion into a rotating motion. Over the years, technical and technological advances have been made to make efficient installations on an industrial scale, especially by the Japanese company "Mitsui Energineering & Shipbuilding", so that Japan currently has over 500 plants that ensure with energy anchored in ports, headlights and light beacons.

Hydra tidal energy

The capture of this form of energy is limited only to certain areas of the seas and oceans, where the difference between flux and reflux is at least 8 m. The use of tidal energy is mentioned in the 9th - 13th centuries, when on Europe's Atlantic coast there were " worn "by the tide. Studies to build industrial plants, based on tidal activity, began only after the Second World War. France achieved its first success in 1966 through the Rance plant in the Gulf of Saint Malo in Brittany, which has a 240 MW power. Here a 750 m long dam was built and the plant has 24 turbines and uses a flow rate of 18,000 m3 / s at a maximum fall of 18.2 m.

The thermal energy of the seas and oceans

This method of unconventional energy capture is based on highlighting the temperature difference between surface and depth, especially in tropical areas where the temperature difference between sea level and 100 m depth is sufficient to put a thermal engine into operation. For this, fluids are used which boil at the surface water temperature and condense at the temperature of the deep water, such as: freon, ammonia, propane, etc. Thus, a modular 100 MW marine thermal energy conversion system has been patented in the US at Kennedy Space Center. And Japan has also built a facility since 1974 at Eurococean.

Hydrogen energy

In the eco-economy, it is estimated that hydrogen will be the fuel of the future that will replace oil, just as coal replaced coal, as coal replaced wood. However, the use of hydrogen as an energy resource presents many unsolved problems both economically and technically and technologically. Problems arise both in hydrogen production, storage, transport, and end use.

The use of hydrogen as an energy source has sparked controversy among scholars, disputes that have led to pros and cons. Of the arguments to mention, hydrogen can be obtained from water, which is abundantly found on the earth, burning hydrogen in outbreaks or combustion cells results in water that does not pose any particular ecological problems, but also secures the closure of the water circuit the nature; (up to 70%), and the amount of air required for burning is lower (280 g air for MJ released) than gasoline, methane, methanol (340 g air for one MJ), combustion of hydrogen no CO2 is produced, thus not contributing to the greenhouse effect, and the amount of nitrogen oxides is lower than that resulting from the combustion of other fuels, due to low combustion air consumption.

Counter-arguments are: 5 times lower calorific value than methane, high gas transportation and storage costs, large pipeline diameters and the use of high-power compressors, which means high electricity consumption, high volume storage tank and compressed transport cylinders, complicated machines for liquid storage due to low hydrogen density (0.09 g / m3), fragility of steels in cylinders and pipes, increased explosion hazard under certain conditions pressure and temperature, given.

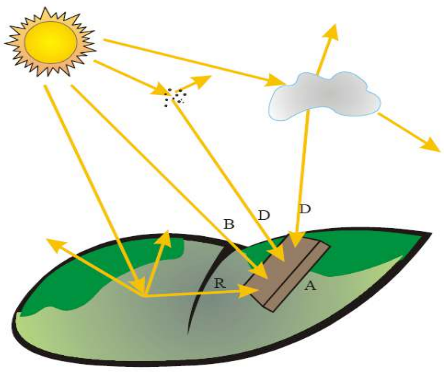

Fig. 5. B - direct solar radiation components; D - diffuse; R - reflected on
A (absorbent surface)

The use of solar energy started to be captured by industrial methods in the 1980s, surpassed worldwide 4000 MW in 2003 (Figure 6).

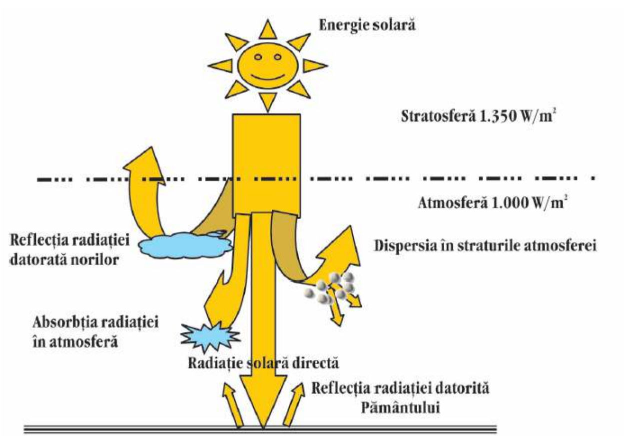

Fig. 6. Scheme of solar energy interactions with the atmosphere, respectively with the terrestrial surface

The solar radiation flux reaching the surface of the Earth is lower than the solar constant, as it crosses the terrestrial atmosphere, with a thickness of more than 50 km, the intensity of the solar radiation is gradually reduced. Mechanisms by which the intensity of solar radiation changes, when the atmosphere is crossed, are absorption and diffusion.

In the atmosphere is absorbed (retained, filtered) almost completely the X-radiation and some of the ultraviolet radiation. Water vapor, carbon dioxide and other gases in the atmosphere contribute to the absorption of solar radiation by the atmosphere. Absorbed radiation is generally transformed into heat, and the diffusion radiance thus obtained is resumed in all directions to the atmosphere. Through these processes, the atmosphere heats up and produces, in turn, a high-wavelength radiation called atmospheric radiation.

In addition to the two mechanisms of varying the intensity of solar radiation, part of the solar radiation is reflected by the earth's atmosphere, or some of its components (air molecules and certain cloud types). By reflection, part of the solar radiation is dissipated (Rayleigh diffusion), and this phenomenon represents the radiance of the celestial vault.

Global radiation from the Sun, on a horizontal ground level surface on a serene day, is the sum of direct radiation and diffuse radiation.

Direct solar radiation depends on the orientation of the receiving surface.

Diffuse solar radiation can be considered the same irrespective of the orientation of the receiving surface, even though there are actually small differences.

The unified thermal energy received from the Sun, measured at the surface of the Earth, perpendicular to the direction of the sun, for the conditions in which the sky is perfectly clear and free of pollution, in the areas of Western Europe, Central Europe and Eastern Europe, around noon, can provide maximum 1000 W / m2. This value represents the sum of direct and diffuse radiation. Solar radiation is influenced by the permanent modification of several important parameters, such as: the height of the sun in the sky (the angle formed by the direction of the sun's rays with the horizontal plane); angle of inclination of the Earth's axis; changing the Earth-Sun distance (approximately 149 million km on an elliptical, slightly eccentric trajectory); geographic latitude, etc.

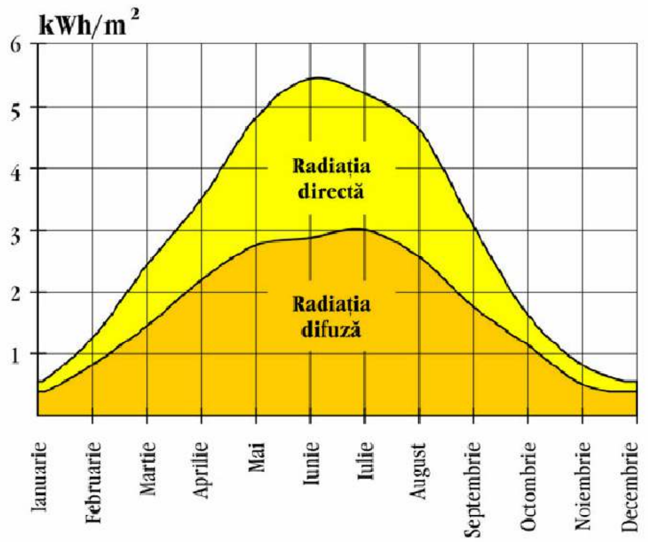

Fig. 7 The ratio of diffuse radiation to direct radiation

Figure 7 shows the ratio of diffuse radiation to direct radiation in global radiation. It is interesting to note that diffuse radiation has a greater weight than direct radiation, which allows to capture the sun's energy even on unenviable days.

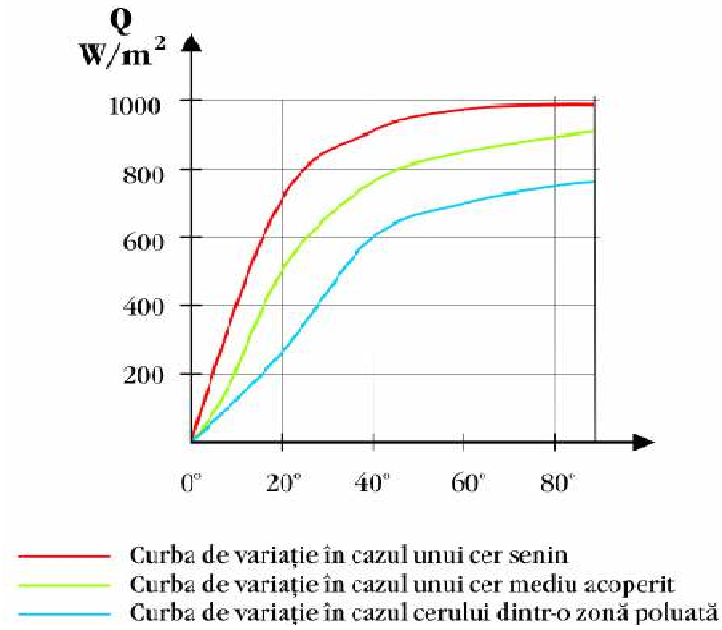

Fig. 8 Variation of solar radiation depending on the direction of solar radiation and various atmospheric conditions

Figure 8 shows the variation of the solar radiation density in relation to the sun's height, ie the angle formed by the direction of the sun's rays with the horizontal plane, for different atmospheric conditions.

The potential for solar energy to be used in Romania, Europe or elsewhere on the earth is particularly important and maps of global solar radiation have been drawn up to highlight. For example, the map of solar radiation intensity in Europe and Romania is shown in Figure 9.

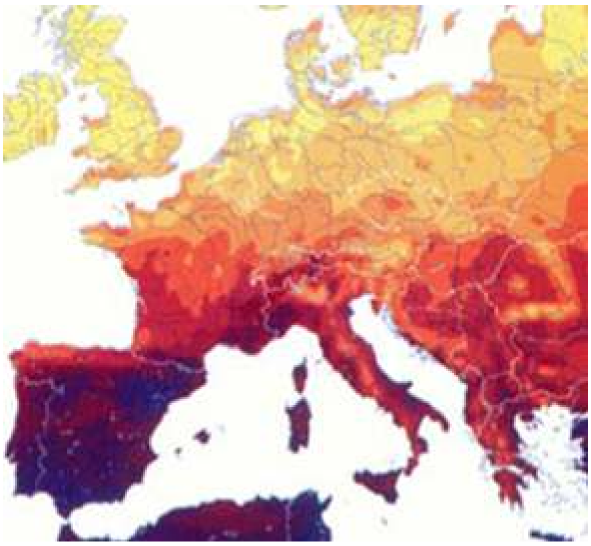

Fig. 9.a Map of solar radiation intensity in Europe and Romania

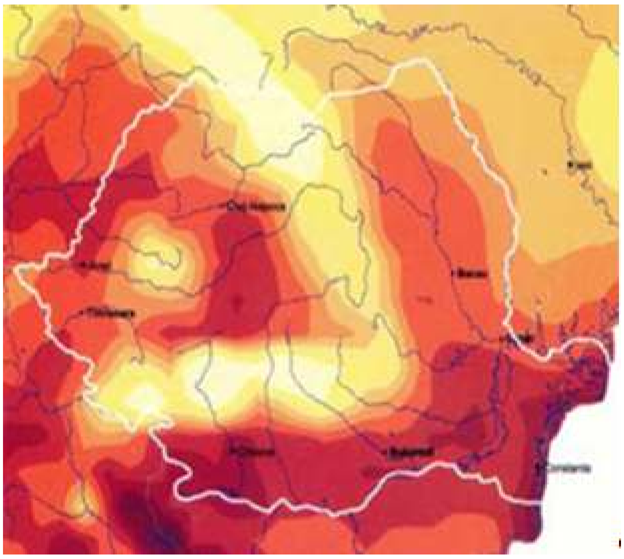

Fig. 9.b Map of solar radiation intensity in Europe and Romania

Wind energy

Wind power has been used since ancient times, but with regard to electricity generation since the last century, the first "huge windmills" have been built, their maximum efficiency being about 60% of the total energy potential that would could be captured, but the average is about 35%. Wind generators should be located in areas with strong winds (minimum 5m / s). Wind energy is captured by wind turbines that have been built since the Middle Ages in the Iberian Peninsula and the North Sea coastline. The most important issue in capturing wind energy is the variability of speed and direction. The wind speed increases with altitude, which is why propellers should be mounted as high as possible, and their fitting on the seashore (due to breezes) is advantageous. The modern wind industry was born in California in the early 1980s. After a rapid onset, the US interest in wind energy has fallen to almost disappearance in the 1990s. Today, in Denmark, 20% of electricity is produced by (the largest percentage contribution in the world), with regions such as Schleswig-Holstein in the north of the country, where in some areas the share of wind energy exceeded 75%, with a generation capacity of 16,000 MW. In the last few years, the United States has resumed its interest in this form of energy, so over 13,000 turbines have been installed in the US over the last few years. In South Dakota, a project is being developed to build a 4,000 MW, a Rolling Thunder project that will power the area around Chicago, and in California it is expected to produce 8% of the electricity by capitalizing on wind power.

There are four qualities for which wind energy deserves special attention: it is abundant, it is cheap, it is inexhaustible and it is clean.

From the environmental point of view of the use of wind farms, the impact on the environment is minimal.

Lately, there is a growing interest in capturing wind energy for the purpose of propulsion of sea-going vessels with medium-height currents.

Geothermal energy

Geothermal energy is generated by the radioactive decomposition of some substructure elements and can be used in both geo-thermo-electric and heating plants. Hot or hot baths have been used for thousands of years, the most experienced in this field being proved to be Romanians, through the famous therme. Today, geothermal energy has various uses, from the production of electricity to the heating of homes, greenhouses, public spaces, commercial and tourist areas, etc.

Energy from biomass

The biological conversion of solar radiation through photosynthesis provides annually, in the form of biomass, a reserve of energy rated at 3x1021 J / year. Currently, biomass supplies 6-13% of the world's energy needs, which means the equivalent of approx. 8.5 million barrels of oil a day. The main biofuels are ethanol and biodiesel, as well as liquid fuels, and biogas.

Ethanol is made from sugar cane, corn, wheat, barley, sugar beet, prairie and poplar grass, and biodiesel is produced from rapeseed, soybean and palm oil. Special achievements in the production and use of liquid biofuels are: Brazil, USA, Western Europe, Canada, India, China, Colombia, Mexico etc. For example, Brazil uses cane as a raw material and produced about 4 billion gallons of ethanol in 2004, providing 40% of its auto fuel need, and the US uses corn as raw material and only made it in 2004 production of more than 3.4 billion gallons of ethanol, accounting for 2% of fuel oil consumption.

However, the production of liquid biofuels will soon be in competition with the food industry and will exert pressure on forests and plantations, posing a threat to the environment's biodiversity and the cost of basic food.

Fuel cells

Fuel cells are classified by the type of electrolyte used. The main types of electrolyte are: Alkaline Fuel Cells (AFC), Molten Carbonate Fuel Cell (MCFC), Phosphoric Acid Fuel Cell (PAFC), Proton Exchange Polymers (PEMFC - Polymer Electrolyte Fuel Cell) and Solid Oxide Fuel Cells (SOFC). The first three types fall into the category of liquid electrolytes while the latter two are solid.

We can conclude that unconventional energies have a fairly large proportion, and of these for marine applications at the current level of technological development, they still have those with a high energy potential in the environment: certainly wind energy when the direction and strength of the wind are appropriate, the energy daylight and sunshine periods as well as wave energy for low power applications applicable to recreational boats during stationary.

The current trends in the capture of renewable energies in the marine environment are the result of the need for the current saving, but especially the technological burdens of the future fossil fuel saving technical solution, with a particular emphasis on reducing the gas emitted by burning them. Global warming and the need to preserve the marine environment and the scenic marine life force us to seek solutions that are as appropriate as possible to make the propulsion of ships more efficient.

4.Conclusions

During 1970-1980, high fuel prices stimulated research on alternative propulsion. In the current context, the arguments about the imminent diminishing of natural resources and the international provisions on ship-source pollution call for energy to be produced, supplied and consumed more efficiently than before. In other words, it is imperative that marine vessels use renewable energy resources.

Renewable energy sources are widespread, but often require large investments to be captured.

Wind energy is considered to be the cheapest energy source. The cost of producing it is zero.

At the beginning of sailing, when seas and oceans were sailboats, wind energy was fully utilized and its advantages led to the appearance of ships with several larger masts and wagons in the desire to benefit as efficiently as possible by the movements of sea air currents.

The strong technological development of the early nineteenth century, both in industrial and scientific research, has for a long time been forgotten the wind power source.

The operation of propulsion engines as well as auxiliary fuels obtained by processing / distillation, fuel oil, gasoline or gasoline have made vessels reach high margins equivalent to the same fuel consumption. Combustion inside the naval engines produces a series of harmful gases that are eliminated in the atmosphere.

In the last period of time the growing demand for merchandise on the shipbuilding market, the delivery of goods in a relatively short time, the increase of ship loading capacities, have led to an increase in the percentage of pollutants contained in the atmosphere.

5.References

[1] Boșneagu R., Scurtu I. C, Weather and oceanographic influence on the maritime navigation, Constanta Maritime University Annals, Year XIV, Vol.21, ISSN 1582-3601, Constanta 2014.

[2] Boşneagu, R., Nedelcu, A.-T., **Scurtu, I.C.,** *Black Sea - The geopolitical, economic, social and military importance*, (2018) Journal of Physics: Conference Series, 1122 (1), art. no. 012006

[3] *O'Rourke R.*, Navy Ship Propulsion Technologies: Options for Reducing Oil Use -- Background for Congress, Congressional Research Service Report for Congress, Washington DC, June 2006.

[4] *Rawson K.J., Tupper E.C.*, Basic ship theory, Fifth edition, Butterworth-Heinemann Publishing, Oxford, 2001.

[5] *Sgrumală M., Bidoae I.*, Proiectarea si construcția navelor mici. Editura Tehnică, București, 1978.

[6] Scurtu I. C, A survey of developments in wave energy, Constanta Maritime University Annals, Year XIV, Vol.20, ISSN 1582-3601, Constanta 2013.

[7] Scurtu I.-C., Minimum deck height of a semisubmersible platform according to black sea environment, Buletinul Științific Academiei "Mircea cel Batran" Constanta, Sectiunea Nautical and management science, 2014 – Issue no. 1 Cod CNCS 884, ISSN 2392-8956, ISSN-L 1454-864X, pg.13-18.

[8] *Trodden D.G., Woodward M.D., Atlar M.*, Accounting for ship manoeuvring motion during propeller selection to reduceCO2 emissions, Ocean Engineering, Elsevier Journal, 2016.

[9] *Tupper E.C.*, Propulsion, in Introduction to Naval Architecture (Fourth Edition), p. 174–217, 2007.

[10] *Țicu R.I.*, Cercetări privind utilizarea surselor de energie neconvențională la propulsia navelor, Teză de doctorat, nepublicată, 2014.

[11] Wilson Arthur - The Living Rock: The Story of Metals Since Earliest Times and Their Impact on Civilization, Woodhead Publishing, 1994.