



LEGAL ASPECTS OF ELECTRIC ENERGY GENERATION IN A FLOATING POWER PLANT

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Abstract

This paper discusses the characteristics of pollution and legal regulations governing investment projects affecting the environment. It describes a combined system of a compression ignition engine and a steam turbine, whose aim, when placed on a floating platform, is to produce electric energy in a so-called distributed generation system. Such a system involves a reciprocating internal combustion engine and a connected steam turbine system that uses the energy contained in the exhaust gas of the combustion engine. The paper ends with synthetic conclusions.

Keywords: *electric energy, floating power plant, environmental pollution*

1. Introduction

Continually changing conditions, increased requirements of customers, as well as growing competition force business entities to take regular actions maximising the efficiency of their operation.

Business entities to a large degree determine the economic development of a country, as well as the welfare of its society. Each of them produces a part of gross domestic product. The new social and economic system that has been developing in Poland since the beginning of the 90s led to the evaluation of free market economy. Processes taking place in the global economy had a dramatic impact on the changes in the conditions under which Polish enterprises operate.

For many years now the solutions to power plant technical systems that would increase their thermodynamic efficiency have been sought. In almost 80% of cases thermal power stations fuelled with solid and liquid or gas fuels involve systems with turbines driving power generators (in the case of high capacity power plants). [20]

The issue of a large amount of noxious substances emitted by conventional power plants to the atmosphere and extensive plaster dumps led to research on solutions that would prevent these phenomena. Furthermore, there is a demand for increased thermodynamic efficiency of a cycle, while reducing the costs of power generation. For that purpose the use of combined systems is considered that would involve a compression ignition engine and a steam turbine cycle. When placed on a floating platform, such a solution would provide for the generation of electric energy in a so-called distributed generation system.

Energy generated in a distributed system, also called distributed generation, involves the

production of energy by small units or production plants directly connected to distribution networks or located in the consumer's power system. They usually generate electric energy using renewable or non-conventional energy sources, often combined with heat generation. One of the basic classifications of distributed generation sources is classification in view of the generated power value. We can differentiate between:

- small distributed generation (units of capacity between 1 kW and 5 MW);
- medium-sized distributed generation (units of capacity between 5 MW and 50 MW);
- large distributed generation (units of capacity between 50 MW and 150 MW);

The aim of the paper is to describe the characteristics of pollution and legal regulations governing investment projects affecting the environment. As a result, the most important issues will be determined that should be stressed during the execution of investment projects. Furthermore, the benefits derived from using a combined system and the advantages in an offshore floating power plant in view of the environmental friendliness of the plant will be analysed.

The paper discusses the possibility of constructing a floating power plant involving combined systems, Wartsila 9RTA96C and MAN Diesel & Turbo 9K98MC-C7.1-TII compression ignition engines and a steam turbine for the load of 90% CMCR (Contract Maximum Continuous Rating), placed on an offshore platform in the Baltic Sea area, as well as other areas as in the map shown in Fig. 1.

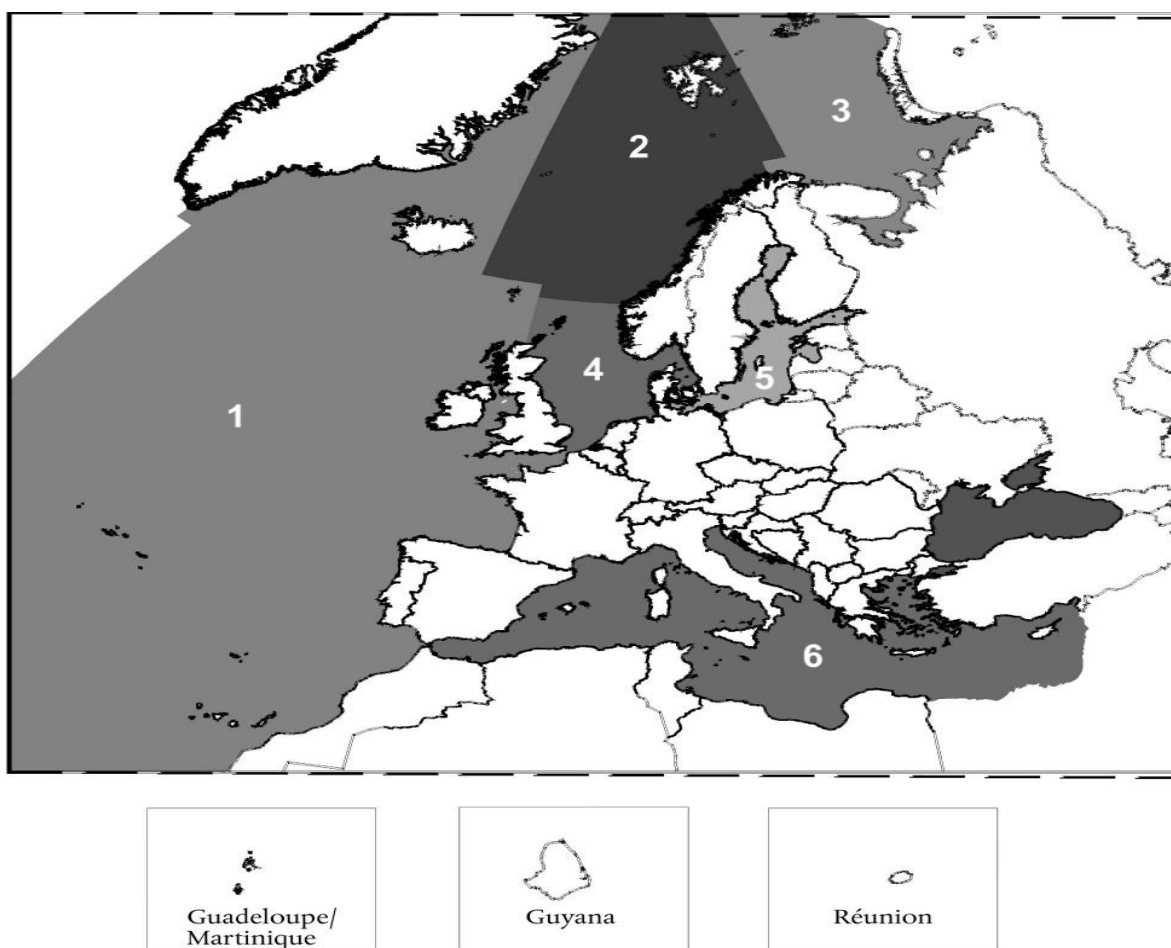


Fig. 1. System A: Ecoregions of transitional waters and coastal waters

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|----|----------------|----|-------------------|
| 1. | Atlantic Ocean | 4. | North Sea |
| 2. | Norwegian Sea | 5. | Baltic Sea |
| 3. | Barents Sea | 6. | Mediterranean Sea |

The Baltic Sea is a small, shallow-water (average depth of 53 m) inland sea connected to the North Sea by narrow and shallow straits. Annually, less than 4% of the Baltic Sea waters is naturally replaced with ocean waters through the straits. Complete regeneration of the sea takes approximately a



quarter of a century, which negatively affects the purity of the sea waters and reduces its self-purifying capacity.

In accordance with a definition provided in the Helsinki Convention, a “*Ship*” means a vessel of any type whatsoever operating in the marine environment and includes hydrofoil boats, air-cushion vehicles, submersibles, floating craft and fixed or floating platforms.[21] That is why this paper lists all pollutants as for ships.

2. Pollution characteristics

Each entity running a business activity performs periodic analyses aimed at verifying whether the goals that were set for it have been met, taking into account environmental protection. This task is becoming more and more difficult for the management of such entities, because complex environmental impact analyses are required.

Environmental pollution may be defined and classified in a number of ways. In accordance with the Environmental Protection Act of 17 January 1980 with subsequent amendments (1994), environmental pollution involves the introduction of solids, liquids, gases or energy into the environment in such an amount or of such composition that may negatively affect human health, climate, nature, soil, water or cause other environmental changes.

Literature dealing with environmental protection provides different definitions of pollution. Here are three such definitions:

- pollution is defined as the presence of foreign components in an element of a system that do not belong in it and corrupt its properties,
- environmental pollution is a situation in which the concentration of substances considered harmful, unnecessary or foreign exceeds their average content in a balanced (“pure”) environment or exceeds permissible norms,
- environmental pollution involves the accumulation of substances that may result in adverse changes in the environment on the surface of the Earth.

Considering the different types of pollutants, the following classification may also be recognised:

- material pollutants: solids, liquids and gases,
- non-material pollutants: thermal pollutants, sound, radioactive and electromagnetic radiation and vibrations.

Considering the elements affected by pollution, the following types of pollution may be recognised:

- air pollution,
- water pollution,
- soil pollution.

Polish law does not explicitly define the marine environment pollution. Only the Water Law Act of 14 October 1974 generally describes the term of water pollution that “involves physical, chemical, biological and other changes in water that result in it not being suitable for the purposes of people or the national economy and cause harmful environmental changes.”

3. Legal regulations concerning environmental pollution

Literature devoted to the marine environment protection most often refers to a definition given by the Intergovernmental Oceanographic Commission (ICO) saying that marine pollution involves the human introduction into the marine environment of substances and energy harmful to the living resources of the sea and posing a threat to human health, hindering sea-involving activities (including fishery) and impairing the quality of sea water from the point of view of its usability and reducing the recreational value of the sea.

The fundamental standards of the European Communities regarding the protection of sea waters include, above all:

1. *Council Directive 76/464/EEC. Discharge of hazardous substances.* It is a framework directive that provides for the elimination or reduction of inland, coastal and territorial waters pollution, in particular caused by hazardous substances, using separate “derivative directives”

specifying the permissible values of hazardous substances emission. Six derivative directives were adopted which specify permissible emission values and quality indicators with respect to water for substances from list I (Council Directives 82/176/EEC, 83/513/EEC, 84/156/EEC, 84/49/EEC, 86/280/EEC, 90/415/EEC).

2. *Council Decision 86/85/EEC. Oil spills.* It concerns five areas of activity related with combating oil spills at sea or larger inland water regions, a list of national and common plans to combat pollution caused by marine oil spills, an inventory of measures for combating oils spills at sea and other. [14]

The register of protected areas required under Article 6 contains the following types of protected areas:[22]

- areas designated for the abstraction of water intended for human consumption under Article 7;
- areas designated for the protection of economically significant aquatic species;
- bodies of water designated as recreational waters, including areas designated as bathing waters under Directive 76/160/EEC;
- nutrient-sensitive areas, including areas designated as vulnerable zones under Directive 91/676/EEC and areas designated as sensitive areas under Directive 91/271/EEC;
- areas designated for the protection of habitats or species where the maintenance or improvement of the status of water is an important factor in their protection, including relevant Natura 2000 sites designated under Directive 92/43/EEC and Directive 79/409/EEC.

Helsinki Convention 74/92

The first Convention on the Protection of the Marine Environment of the Baltic Sea Area was signed on 22 March 1974 in Helsinki. It entered into force on 3 May 1980. It covers the entire surface area of the Baltic Sea with the Danish straits and requires all of the Baltic countries to:

- prevent pollution from ships,
- prevent pollution from the land,
- prevent waste dumping,
- prevent pollution through the atmosphere,
- organise patrolling and spills combating services,
- seek scientific and technical cooperation,

MARPOL 1973/78 Convention

The International Convention for the Prevention of Pollution from Ships referred to as the MARPOL (Marine Pollution) 73/38 Convention is a global convention covering all sea areas. Poland is a party to the convention. The convention only deals with pollution from ships. It divides sea areas into two categories:

- special areas,
- other areas.

The convention does not cover naval vessels nor national service ships (Maritime Search and Rescue Service, Border Guard, Police, Customs Offices, research ships, training ships and vessels of Maritime Offices).

The Marine Environment Protection Committee (MEPC) is one of the 5 committees of the IMO (International Maritime Organization). The Centre for IMO Affairs operates within the Polish Register of Ships and includes the national section of the MEPC.

The actions of the maritime administration of Poland arising from the MARPOL 73/78 Convention include:

1. enforcement of the convention requirements through national regulations based on the MARPOL 73/78 Convention (Act on Areas of Poland and Maritime Administration of 1991, Act on the Prevention of Sea Pollution by Ships of 1995, Port Regulations of 1994),
2. conducting ships inspections as regards the fulfilment of marine environment protection requirements,
3. conducting investigations in cases of the MARPOL 73/78 Convention provisions infringement and penalising the perpetrators,
4. mandatory annual reporting to the IMO as regards the imposed fines, apprehended ships and results of conducted inspections,



5. mandatory providing of the ports with equipment collecting waste from ships,
6. participation of maritime administration representatives in the sessions of the IMO's Marine Environment Protection Committee and in working groups,
7. required ship documentation is issued by the Polish Register of Ships in the name of the maritime administration of Poland.

Other common conventions:

1. International Convention Relating to Intervention on the High Seas in Cases of Oil Pollution Casualties, 1969,
2. International Convention on Civil Liability for Oil Pollution Damage, 1969,
3. International Convention on the Establishment of an International Fund for Compensation for Oil Pollution Damage, 1971,
4. Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, 1972,
5. Protocol Relating to Intervention on the High Seas in Cases of Pollution by Substances other than Oil, 1973 (Bańkowski, 1985).

Regional conventions and agreements:

1. The Agreement for Cooperation in Dealing with Pollution of the North Sea by Oil, 1969, was signed by all of the North Sea states,
2. The Agreement Concerning Cooperation in Taking Measures Against Pollution of the Sea by Oil, 1971, was signed by Denmark, Finland, Norway and Sweden,
3. Convention for the Prevention of Marine Pollution by Dumping from Ships and Aircraft, 1972,
4. Convention for the Prevention of Marine Pollution from Land, 1974,
5. Convention for Protection of the Mediterranean Sea against Pollution, 1976,
6. Agreement between Denmark and Sweden on the Protection of the Øresund Area Against Pollution, 1974.

Conclusions

It must be kept in mind that the issue of marine environment protection against oil-derivative pollution is only a part of the actions attempted at preventing environmental degradation all over the world. The approaches towards those environmental issues that can only be resolved on a worldwide scale are greatly differentiated. Highly developed countries are already interested in protection in a broad sense of the word. Other countries, depending on the level of environmental degradation and similarly urgent social and economic challenges, are treating this issue more or less prospectively.

Aspects of environmental protection in Polish maritime economy are becoming more and more urgent both due to the level of the Baltic Sea pollution, as well as the requirements imposed by international conventions signed by Poland. Positive changes are taking place in Poland as regards legal regulations of marine environment protection, since many relevant, important legal acts have been adopted. As a marine state, Poland should also devote considerable effort to bring about the ratification of international conventions whose ratification is hindered due to their restrictive nature.

Actions aimed at protecting the marine environment would provide future generations with clean air, unpolluted beaches and the opportunity for learning about the biological life of the Baltic Sea whose existence is more and more threatened.

The proposed concept of power generation in floating power plants has the following advantages:

- a. in view of environmental protection:
 - reduced CO₂, NO_x emissions as a result of the increase in the system efficiency and the reduced emission resulting from the engine structure. What is more, the reduction of SO_x emissions due to the application of sulphur-recovery systems,
 - diversification of primary energy sources that reduces coal consumption and increases liquid fuels consumption,
 - lack of slag and ash,
 - lack of complications related with water cooling the condenser, minor impact on the environment related with water management,



b. other:

- increased generation of power in the north of Poland,
- shorter construction time, when compared to a conventional power plant, and the possibility of gradual launching. First, the compression ignition engine is put into operation, then, during its operation, a combined system with a steam turbine is constructed,
- mobile possibilities – a floating platform.

References

- [1] Bławat, F., *Analiza ekonomiczna*, Wydawnictwo Politechniki Gdańskiej, Gdańsk 2001.
- [2] Dębski, W., *Teoretyczne i praktyczne aspekty zarządzania finansami przedsiębiorstwa*, PWN, Warsaw 2005.
- [3] Wiszniewski, A., *Generacja rozproszona w nowoczesnej polityce energetycznej – wybrane problemy i wyzwania*, Warsaw 2012
- [4] Dzida, M., Olszewski, W.: *Comparing combined gas turbine/steam turbine and marine low speed piston engine/steam turbine systems in naval applications*, Polish Maritime Research, Vol. 18, No. 4(71), pp. 0-48, 2011.
- [5] Dzida, M., Dzida, S., Girtler, J.: *Możliwości zwiększenia sprawności siłowni okrętowej z układem napędowym silnik spalinowy tłokowy – turbina gazowa – turbina parowa przy współdziałaniu silnika głównego z turbiną gazową przy zasilaniu szeregowym turbiną parową*, Polish Maritime Research, No. 1 (59), Vol. 16, pp. 47-52, 2009.
- [6] *Main Engine Room Data*, mandieselturbo.com/ceas/index.html.
- [7] Olszewski, W.: *Możliwości zastosowania obiegu kombinowanego w siłowniach okrętowych oraz mobilnych elektrowniach morskich*, Biomeditech – Badania i Innowacje, Zeszyty naukowe, pp. 126-128, Gdańsk 2011.
- [8] *Sulzer RTA 96C. Engine Selection and Project Manual*, Wartsila, June 2001.
- [9] Olszewski, W.: *Possible use of combined diesel engine/steam turbine in ship power plant*, Zeszyty Naukowe, Szczecin Maritime University, Vol. 28(100), No. 1, pp. 88- 94, 2011.
- [10] Andrulewicz, E., 1990, *Węglowodory w wodzie morskiej*, *Studia i Materiały Oceanologiczne*, 57, 17-24.
- [11] Andrulewicz, E., 1994, *Morze Bałtyckie, jego zagrożenia i ochrona*, PIOŚ, p. 56, Warsaw.
- [12] Bądkowski, A., Dubrawski, R., Gruszczyński, B., 1977, *Problemy zanieczyszczenia morza*, Wydawnictwo Instytutu Morskiego, part I, p. 109, Gdańsk.
- [13] Bugajski, R., 2001, *Zagrożenia ekologiczne polskich obszarów morskich*, *Przegląd Morski*, Article 5, February 2001.
- [14] Ciechanowicz-McLean, J., 2001, *Międzynarodowe prawo ochrony środowiska*, Wydawnictwo Prawnicze LexisNexis, Ed. II, pp. 103-129, Warsaw.
- [15] Dubrawski, R., Gruszczyński, B., 1985, *Problemy zanieczyszczenia środowiska morskiego*, Wydawnictwo Instytutu Morskiego, No. 858, p. 84.
- [16] Korzeniewski, K., 1998, *Ochrona środowiska morskiego*, Wydawnictwo Uniwersytetu Gdańskiego, pp. 58-101.
- [17] Małaczyński, M., 1977, *Ochrona środowiska morskiego przed zanieczyszczeniami ze statków*, Wydawnictwo Politechniki Gdańskiej, Gdańsk, p. 84.
- [18] Małaczyński, M., 1979, *Technika ochrony przed zanieczyszczeniami ze statków*, Wydawnictwo Morskie, Gdańsk.
- [19] Różańska, Z., 1987, *Zasoby, zanieczyszczenia i ochrona wód morskich ze szczególnym uwzględnieniem Bałtyku*, Państwowe Wydawnictwo Naukowe, Warsaw.
- [20] Cire.pl, Electric energy market.
- [21] *Helsinki CONVENTION of 9 April 1992 on the Protection of the Marine Environment of the Baltic Sea Area*, (Journal of Laws of 14 April 2000).
- [22] *DIRECTIVE 2000/60/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 23 October 2000 establishing a framework for the community action in the field of water policy* .