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# USE OF RENEWABLE ENERGY SOURCES

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***Abstract****. The issue paper is to present renewable energy sources, insisting mainly on wind and solar energy. These two sources are analyzed in the context of Romania in particular and the EU in general. It is noted that wind energy was used in navigation since about 5000 years ago as existing wind sailing canvases. A turbine with horizontal axis is usually coupled with photovoltaic systems. Photovoltaic energy knows a growth rate increased. At the end of the paper are presented possible structure of a wind and photovoltaic systems.*
***Keywords:*** *renewable energy, photovoltaic energy, solar energy, wind energy.*

## 1. INTRODUCTION

**The main types of energy sources and their comparative characteristics**

At this stage the humanity benefit, in fact, of three categories of energy sources, based respectively on:

-Burning fossil fuels (coal, oil, gas);

-Nuclear fission;

-capture and renewable energy conversion (solar energy, wind energy, water potential energy, geothermal energy);

a) **Fossil fuels**-for the last two centuries have served as the basis modern energy being energetic support of industrialization and scientific technological progress made over this period. Today about 90% of global energy demands are satisfied by using fossil fuels.

There are many characteristic handicaps of these energy resources, including two the worst consequences:

- limited amount of explored reserves by the fossil fuels;

- strong impact on the environment, passed over in silence in not too far past, question the possibility in the near future based on burning fossil fuels energy.

Deposits of oil, natural gas are really limited and, in a short period, it can be exhausted. (Table 1)

***Global reserves energy resources***

| Type of resources | Natural reserves*,Gtep | Global production | Reserves, Years |
|---|---|---|---|
| Oil | 140 | 3,45 | 40 |
| Natural gas | 135 | 2,2 | 64 |
| Coal**** | 984205 | 2,2 | 155 |
| Uranium** | 40->2000 | 0,34 | 60->2500*** |

* economic exploring;
**depending on the utilized technology;
*** starting from a consumption of 0.65 Gtep;
**** million tons;

b) **Nuclear energy**

Nuclear energy era starting in the 70s of the twentieth century, knows a spectacular development and more promising in the 80s, winning in the late of 90s, power generation of the most developed European countries, the U.S and Canada.

The functioning of nuclear plants is not accompanied by emissions of harmful gases and nuclear material raw reserves are sufficient for many centuries for now on.

In the long term, nuclear power engineering have chances to reestablish his position not insignificant, especially in producing electricity but this will happen only after developing a new technology capable of providing the safe operation of power plants and the radioactive waste processing.

c) **Renewable sources**

Are the sources that are regenerating as they are consumed.

The most important renewable energy sources (RES) are:

- wind energy;
- energy of the sun;
- hydraulic energy of rivers;
- energy of fluxes-refluxes and waves of the sea;
- geothermal energy;
- biomass energy;

The principal criteria that determine the prospects exploitation of renewable energy are:

- the spread quite uniformly around the globe and access to their use of the majority of the world countries;

- finding near their place of use and, as a result, lack of any need to carry energy at long distances;

- public access both at producing as well as the use of energy;

- most of renewable energy sources are nonpolluting.

These important advantages have led the industrialized countries and many developing countries, to progressively build a new energy system which takes into account the non-traditional energy sources.

The disadvantages that they held a long time of their implementation scale are:

renewable energy is dispersed, resulting in high costs of final energy production facilities, designed for consumption; irregularity of distribution in time; lack of storage ,for forming reserves.

## 2 THE RENEWABLE ENERGY SOURCES POTENTIAL IN ROMANIA

a) **The solar energy.**

Solar energy potential is given by the average amount of energy derived from solar radiation falling on horizontal surfaces, which in Romania is of about 1100 kWh/m2-year.

Map of solar radiation in Romania was elaborated on the basis of multiannual average data recorded by the National Institute of Meteorology and Hydrology (INMH), processed and correlated with physical observations and measurements made in the field by specialized institutions. In Romania have identified five geographical areas (0 - IV), differentiated by measuring the energy flow. Geographical distribution of solar energy potential shows that more than half of Romania's surface receives annual energy flow between 1000 and 1300 kWh/m2-year kWh/m2-year.

***The distribution of solar energy potential in Romania***

| Area | Solar energy potential recorded |
|---|---|
| 0 | Over 1250 kWh/m2-year |
| I | 1250 kWh/m2-year −1150 kWh/m2 |
| II | 1150 kWh/m2-year −1050 kWh/m2 |
| III | 1050 kWh/m2-year −950 kWh/m2 |
| IV | Under 950kWh/m2-year |

*Source: Research and development studies by ICEMENERG*

Conversion of solar radiation into electricity is done by photovoltaic solar modules made of configurations and different sizes. Exploitable potential of producing electricity by photovoltaic systems is about 1200 GWh /year.

Investment cost for the development of photovoltaic solar modules in the network registered a favorable trend over the past decades, a solar module price decreased systematically reaching now about $ 6 /1W (installed).

The electricity price produced from solar photovoltaic sources varies between 25 cents /kWh and 50 cents / kWh. For supplying small isolated consumers and consumption of energy, photovoltaic systems offers attractive economic alternative , if one takes into account the high cost for connecting consumers to the national power electricity grid connected to the system. In Romania have made photovoltaic power systems and various operating under different programs in research, development and demonstration, as follows:

- autonomous systems for supplying isolated consumers (individual households, socio-cultural centers in the Apuseni Mountains, Black Sea, Danube Delta, etc.) radio stations, telecommunications, water pumping facilities, street lighting or traffic signal, included as objectives in the rural electrification program;
- the connected systems to electricity grid (photovoltaic pilot stations with mobile panels, integrated into buildings, etc.).

b) **Wind energy**

In Romania have identified five different wind zones (I - V) based on existing energy potential, environmental conditions and geographical topography. Wind map of Romania was developed, taking into account potential wind energy sources to the average height of 50 meters, based on data and information collected from geographical forecast since 1990, until now. From the results recorded revealed that Romania is at in a temperate continental climate, with high wind energy potential in the Black Sea coast, highlands of Moldavia and Dobrogea ("mild climate") or in the mountains ("severely environment"). In regions with relatively good wind potential favorable locations were located, if intended "exploiting the effect energy flow over the top of the hill" or "the effect of sewage air currents."

Based on evaluation and interpretation of data recorded in Romania shows that can put wind turbines with a total power of up to 14,000 MW, which means a power input of about 23,000 GWh/ year.

According to preliminary assessments in the seaside area, including the off-shore, short and medium term, harnessed wind energy potential is about 2000 MW, with an average power of 4500GWh / year.

***Technical and economic elements to exploit the potential areas of wind energy in Romania***

| **Speed, energy** / **Photo geographical area** | **Montana high** (m/s; W/m2) | **Open sea** (m/s; W/m2) | **Coastal zone** (m/s; W/m2) | **Flat land** (m/s; W/m2) | **Hills and plates** (m/s; W/m2) |
|---|---|---|---|---|---|
| **I** | >11,0;>1800 | >9,0;>800 | >8,5;>700 | >7,5;>500 | >6,0;>250 |
| **II** | 10,0-1,5; 1200-1800 | 8,0-9,0; 300-800 | 7,0-8; 400-700 | 6,5-7,5; 300-500 | 5,0-6,0; 150-250 |
| **III** | 8,5-10,0; 700-1200 | 7,0-8,0; 400-600 | 6,0-7,0; 250-400 | 5,5-8,5; 200-300 | 4,5-5,0; 100-150 |
| **IV** | 7,0-8,5; 400-700 | 5,5-7,0; 200-400 | 5,0-6,0; 150-250 | 4,5-5,5; 100-200 | 3,5-4,5; 50-100 |
| **V** | <7.0;<400 | <5,5;<200 | <5,0;<150 | <4,5;<100 | <3,3;<50 |

*(Source: ICEMENERG)*

Wind energy potentials in the economic efficiency require the use of technologies and equipment (aero-generators groups rated power from 750kW to 2000 kW).

Worldwide, "wind energy" is in a stage of "technological maturity", but in Romania, the share of electricity from renewable wind energy balance remains far below the real possibilities of their efficient utilization. Green Certificates are issued to manufacturers, for each unit of energy produced from renewable sources by an eligible institution and are denominated in units of energy (e.g. 1 MWh). Certificates of origin issued nationwide will be mutually recognized on the European market of electricity. The main procedures for promoting the trade with Green Certificates are: eligible producers accreditation issue of certificates quality control (verification and audit) mechanisms for the transfer and sale of certificates .For the implementation of these procedures are necessary responsible institutions for the control, implementation and operation.

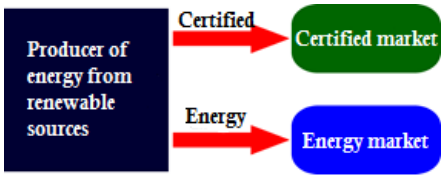


***Fig.1. Support schemes for renewable energy sources***

In 2010, with turnover of Green Certificates trading in Europe is estimated at 20 billion euros.

### *2.1. Preconditions for the realization of renewable sources of energy in Romania*

The General objectives of the strategy of exploiting renewable energy sources depend on:

- integration of renewable energy sources in the national energy system structure;
- reduction of functional and technical barriers and psycho-social in the process of exploiting renewable energy sources, together with identification of cost and economic efficiency;
- promotion of private investments and creating conditions to facilitate the access of foreign capital on renewable sources of energy;
- ensuring the independence of the energy consumption of national economy;
- ensuring, as appropriate, to supply energy to communities isolated by exploiting the potential of local renewable sources;
- creating conditions for the participation of Romania in the European market of "Green Certificates" for energy from renewable sources.

Solar photovoltaic systems- find usefulness in their applications in isolated geographical areas or with limited possibilities of access to electric network. Photovoltaic applications have been identified for several types of projects:

- the autonomous photovoltaic systems for rural electrification, with applications in Apuseni mountains or other mountain areas, in Northern Moldova, nature parks (e.g., Delta), etc.
- photovoltaic systems connected to the network of transmission and distribution of electricity: solar-photovoltaic mini centrals (a few hundred kW to 1 MW), the Black Sea coastline in the area, with a potential solar attractiveness and potential for use on surfaces (on the principle of compensation for the additional consumption to compensate for seasonal or power lines network in the area of the Danube Delta);
- photovoltaic systems (1 kW-5 kW) connected to the network (born in big cities, seaside, holiday homes, etc.).

The realization of photovoltaic modules connected to the network can be a viable solution in distinct applications, as a result of specific reduced costs (for example: irrigation systems in agriculture) [Andea2010a].

**Wind energy:** specialized studies and analyses on wind energy sources like wind power potential exploitable demonstrates of Romania is about 14,000 MW (power installed), which can provide a quantity of energy of approximately 23,000 GWh /year.

Weather-climate data analysis and investigations on the ground led to the identification of locations with favorable wind energy potential for wind central techno-economic performance. In the area of continental shelf of the Black Sea ("off-shore"), studies undertaken highlight the wind energy potential of around 2000 MW.

Off-shore locations, 3 km to 5 km of coastline on the continental shelf (up to 5 m water depth), are considered to be effective in the long term (over 20 years).

## 3. AERO-ELECTRICAL AGGREGATES (A.A.E)

Of renewable energy sources, wind energy presents one of the most likely current and efficiency use. Converting wind energy is the source of electricity generation that increases fastest because of the capacity development around the world, and it is estimated that it will remain so in the next decade. Electrical installations of wind turbines in the power systems have developed rapidly, especially in the past 20 years, while international statistics on growth rate indicates that this development will continue. Wind energy conversion technology in electric power is made with alternating current electrical generators, synchronous and asynchronous (induction).

Energy that can be obtained from wind, through wind turbines depends on the kinetic energy of the position, and on the other side of the turbine design.

Recent automotive wind turbines showed a real interest in energy conversion systems with variable speed. Through the use of variable speed can increase significantly, thus capturing the dwarfing of wind power and aerodynamic mechanics pressure noise.

And that's why wind power generation is attractive and is challenging them to focus research on husbandry, update (new topologies both on the design of the car and on the aerodynamics of the turbine) and its use as an energy that don't pollute.

### 3.1. A brief history of the use of wind power

As a source of energy the wind is known to mankind for over 10,000 years. At the civilization horizon, wind energy is used in maritime navigation. It is assumed that the ancient Egyptians went under canvases with 5000 years ago.

Around the year 700 in Afghanistan wind machines with vertical axis of rotation is used for milling the grain. Famous for wind turbines (windmills with propellers connected to Tower) assured the operation of irrigation systems on the island of Crete in the Mediterranean. Grain mill who worked on the basis of wind, are one of the greatest performances of the centuries of the middle ages. In the 14th century Dutch have improved the model of wind mills, spread throughout the Middle East, and began to use the wind to wide-ranging gym grind grains.

In 1854, in the US there is a water pump which operates on the basis of wind energy. As construction, this pump looks like the model of wind mills, but have several palettes (arms) and a wind direction to. By 1940, in USA over 6 million installations of this type are used for pumping water and production of electricity. The premise of Wild West conquest is reckoned, due to the possibility of providing water to farms and livestock. In the mid-20th century, the use of wind energy occurs at the end, being replaced with a modern energy source-oil.

Interest to the energy produced by wind from the oil crisis breaks out, known to mankind in the last decades (at the start of the 1970s), due to the rapid growth of oil prices.

The necessity to use the wind, are directed primarily towards for producing electricity for industrialized nations because the pumps are not important for them.

Major wind power potential is observed on marine coastline on ups and on the mountains. Wind influences on the resources of the Earth and this geographic barrier placed at heights of up to 100 meters. That is why the wind, in a greater extent depends on local conditions (landform), than the sun. In mountain areas, for example, two surfaces may have solar potential equal, but the wind may be different due to the difference on landform and directions of air flow.

The optimal variant is the combination in a system of solar and wind. Symbiotic systems also provide a higher electricity productivity in comparison with photoelectric plants or wind or taken apart.

The amount of energy produced from wind depends on the density of the air, the surface of the propeller and wind speed to power the third.

On the surface of Earth vegetation and buildings on it are a factor which influences the decrease of wind speed. Farther we get of the surface, the influence of the relief shrinks on the movement of air masses. In other words: higher you are the wind speed is bigger. At heights of about a kilometer from the sea surface topography, virtually don't influence wind speed. In the bottom layers of the atmosphere, a major influence on speed it has the contact with the surface of the Earth: if the landform is complicated, the wind speed is lower. He slows down in big cities and forests. But large surfaces as on Black Sea coast, practically doesn't have a very significant influence over the wind. Buildings, forests, and other barriers aren't only slow the wind but also creates turbulent air flows.

**Specialists classify landform surface in:**

**0** - water surface (sea level);

**0,5** - a completely open landform with the right surface (the runway departure);

**1** - open agricultural commune without fences and high building, with little ups;

**1,5** - agricultural surfaces, with buildings up to 8 meters in height, constructed each other at about 1250 m;

**2** - agricultural surfaces, with buildings up to 8 meters in height, constructed each other at about 500 m;

**2,5** - agricultural surfaces with large number of buildings and vegetation of up to 8 meters in height located at 250 m from one another;

**3** - townships, cities with a large amount of buildings;

**3,5** - cities with high buildings;

**4** - big cities with high buildings (skyscraper).

Main technical parameter which determines the success of the wind turbine is the annual energy produced, which at his turn is determined by parameters such as average wind speed, wind speed statistics distribution, distribution of wind directions, the intensity of the wind and the harshness of the terrain. Of these, the most sensitive and important is wind speed, which increases with the height from the ground. This led to quitting in large part to the vertical axis wind turbines in favor of more traditional configuration high horizontal axis. With all that wind energy is considered as an organic option for power, she has some negative influences on the environment related to its use. These include: visual, acoustic emission of consequence on land, the impact on the lives of birds, the shadow caused by electromagnetic interference and to rotor can influence the reception of radio signals, radar and TV. Aspects of acoustic emissions were reduced because of progress in research by aero-acoustic design tools and configurations of palettes that led to getting some palettes a lot more silent. The impact on the lives of the birds seems to be a relatively minor problem.

Impact on bird life appears to be a relatively minor issue. Besides being competitive as a cost and ecological, wind power has some advantages over fossil fuel plants and even to other renewable energy sources.

First it is modular: the production capacity of wind farms can be easily extended with new turbines that can be manufactured and installed easily, which is not the case with nuclear or coal. In addition, a repair to a wind turbine does not affect the energy production of others turbines. In the second place the energy produced by wind turbines can lead to depreciation of materials used to make them in about 3-4 months in case of good sites. In the third place, during normal operation, air emissions are not produced.

**3.2. Configurations and basic characteristics of wind turbines**

The basic system that converts the wind energy is the wind turbine. There are two basic configurations depending on the general axis of rotation of the turbine rotor blades:

Horizontal axis wind turbines with rotation axis parallel to the wind.

Vertical axis wind turbines with rotation axis perpendicular to the wind.

As shown in the figure above, the main components of a wind energy conversion system are: the turbine rotor blades components, electric generator, which can be synchronous or synchronous (induction), the gearbox, which may be missing if using synchronous generators, mechanical brake and the support system that may have a height of over 50 meters, depending on where it is placed the turbine and the power of the generator. Also, wind turbines may or may not be fitted with a blade pitch control system and monitoring and control equipment. The power system that converts is presented schematically in Fig.2.:

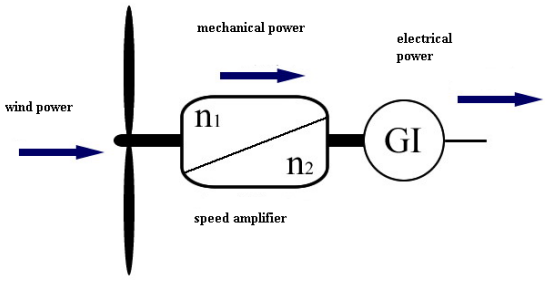


***Fig.2. Electromechanical conversion of wind power using induction generators***

**3.3. Diesel / solar / air / electric autonomous power systems**

These systems has the disadvantage of using diesel generators synchronous groups, relatively more complicated,
larger, heavier, more expensive and difficult to maintain than asynchronous generators, claiming the speed control / frequency and voltage control distinct subsystems:

- Voltage control system, common to both groups, with action on synchronous generator excitation (when there is wind power in excess of consumer requirements ,the diesel engine is turned off and synchronous generator, disconnected by the diesel engine, works in synchronous compensator scheme );
- Common system of the diesel engine speed control, which provides the frequency for the entire network (including aero electric group);
- Frequency regulation system of the network when the diesel engine is stopped (when there is excess of energy at the aero electric group) with variable electronic power.

**Hybrid wind power systems**

Hybrid wind power systems can be used in combination with other devices of generating, especially with low power
generator where we can add a battery, used to store energy.

Hybrid wind power systems can be used in combination with other devices of generating, with low power generator
that can add a battery used to store energy. In this case can also collect advantages of both power generation systems: the
wind power reduce the fuel consumption of the generator, the battery reduces the power of the generator, the presence of the diesel generator reduces the size of wind turbine and the capacity of the battery and overall system reliability is increased.

Using such hybrid system is however accompanied by additional issues for each component power selection, the system optimization and the production cost of a kWh.
The following figure is, described, using a block diagram, the configuration of a hybrid system:

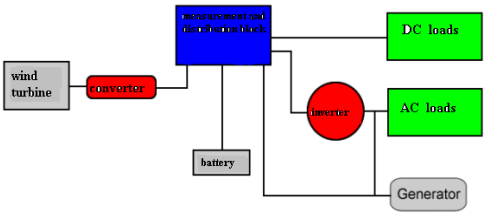


***Fig.3. Hybrid Structure***

Notes: This system uses two complementary energy sources:

A primary source: wind power converted to electricity using a wind turbine (inverter AC / DC is integrated in the system); A secondary source of fossil fuel (diesel or petrol) converted into electrical energy (as) with a generator.

The battery is used as a storage system and as a buffer between power input and output. The generator supplies
power directly to customers and simultaneously provides battery charging through a AC/DC converter .

Electrical power produced by the electric generator ensures with priority the powering of the consumers but if the power is not sufficient, the remaining energy is provided by the battery or the secondary generator if the battery is not charged. When the wind turbine power is higher than the electric charge, the excess is stored in the battery or it is lost if the battery is fully charged. The electric generator starts only when the battery power level is too low to power consumers and stops working when the battery has reached the maximum capacity of charging.

**The structure of a hybrid wind-photovoltaic system:**

The structure of a hybrid wind-photovoltaic system is presented in the following figure:

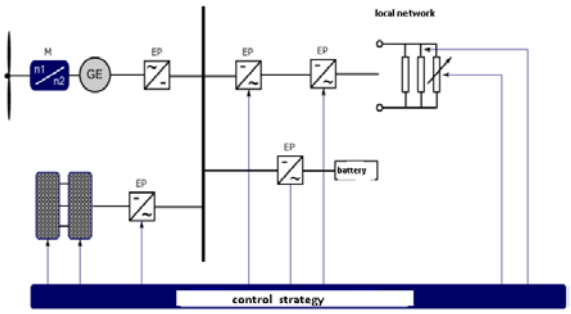


***Fig.4. Block diagram of a hybrid wind-photovoltaic system***

The hybrid wind-photovoltaic system converts wind power and solar power in electricity. The system is composed by a synchronous generator with permanent magnets, a variable speed wind turbine, a group of photovoltaic panels, and a system of batteries which stores the energy surplus.

**3.4. Conclusions on A.A.E.**

The most common types of electric machines and static power converters in electromechanical conversion of renewable sources have been evaluated.

Relying on the above note the following: A.A.E. currently the most popular in the world are with horizontal axis and are composed of three blades; Current trends in this domain are directed to variable speed systems, especially for high power domains (> 2 MW); One of the most important challenges in this domain refers to applications of autonomous low power hybrid wind power systems intended for isolated places.

**Photovoltaic energy**

***Photovoltaic energy*** is electric energy obtained from the sun's energy through photovoltaic elements.

***Photovoltaic solar modules*** are solid state semiconductor devices without moving parts which convert sunlight into electricity as DC. Even though at present the cost of electricity produced by PV systems is still higher than the majority of the other competitive technologies, it is expected to continue its steady decline.

***Photovoltaic systems*** are divided into:

Autonomous systems, consists only of photovoltaic modules. May contain regulatory and batteries.

Autonomous hybrid system with photovoltaic panels
(Photo: DIERET Course)

Hybrid systems, which is a combination of photoelectric elements and other sources for electricity generation: wind generators, diesel and others. These systems use batteries, and lower capacities and regulatory

Systems connected to power grids - are practically small power plants that deliver electricity directly into common network.

Practical efficiency of mass-produced photo to elements is:

- 16 -17% for mono-crystalline silicon;
- 14 -15% for polycrystalline silicon;
- 8 - 9% for amorphous silicon.

The quality of Photovoltaic elements products is different, but most manufacturers guarantee a period of use between 20-25 years and 10 years for the initial capacity.

The basic criteria for comparison of different types of elements, is the price of the peak capacity watt and not by the nominal efficiency. The price of a kW is from 2 to $ 6.

**Advantages of photovoltaic elements**

**- High security -** photovoltaic elements were originally developed as cosmic technologies, resistant to extreme conditions and having a long life, today these elements are used to obtain daily electricity on Earth, maintaining the original safety qualities;

- **Low running costs** - elements are using sunlight, a free fuel. Due to lack of moving parts, do not require special care. Them are profitable, especially in isolated areas, for example, communication stations, lodges, other;

- **Ecologically clean** - does not consume fossil fuels, so there is no pollution, and the lack of moving parts does not make noise (do not produce noise), so it can be used directly to consumers.

- **Convenience and low cost installation** - PV systems can have different sizes, being designed for consumer preferences, then increasing or decreasing capacity. They can be mobile and can, therefore, be used in various places.

- **Low costs for transporting the energy** - being installed near the consumers does not require network or long lengths electricity transmission wires. This is a top priority because it is known that transportation costs are about 50% of final energy.

**Advantages of using solar panels:**

- Are easy to install;
- does not have moving parts, pumps etc.
- high reliability, lifetime 20 years;
- the energy produced can be stored batteries and then used according to need or if it is too much it can be delivered to the national network.

Besides these advantages photovoltaic systems have some disadvantages:

- the surface required for mounting the panels must be larger;
- high initial investment.

**CONCLUSIONS**

Ships power systems, during the last period of time, require the use of renewable energy.

From the scope of renewable energy sources, in this chapter were held in particularly solar and wind power as well as identifying feasible renewable energy sources on ships. For this purpose, wind and solar power is stored in batteries, significantly reducing diesel consumption of the diesel generators.

There are highlighted the following analysis:

• Analysis of the evolving of wind power with possibilities to implement it on the ships;
• Critical analysis of the possibility of using solar power in the electricity system of the ship.

Despite their recent success, renewable energy sources had difficulties in the past succeeding in markets that were dominated by traditional fossil fuel plants. This is partially due to the fact that renewable energy technologies and other new technologies are being manufactured in series as in the past they assumed higher capital costs compared to traditional facilities, but also because plants based on coal, oil and gas have received a range of indirect subsidies over the years. Yet another limitation has

been given by the fugitive nature of some renewable energy sources such as wind and solar power.

Until now studies have shown that the potential of renewable energy is enormous, and can cover the energy demands. Today renewable sources of energy provides between 15-20% of total energy demand in the world.

Renewable energy technologies tend to be characterized by relatively low environment costs.

A fundamental problem for any new technology is that, by definition, does not have the same performance proofs as older systems. Both the solar photovoltaic and wind power have large increases in their sales, decreasing capital costs and energy costs and the performance continues to grow.

Renewable energy sources have an important energetic potential and have an unlimited availability offer on local and national use. Valorization of renewable energy sources is based on three important premises granted by them: accessibility, availability and acceptability. Renewable energy sources can contribute to the current electricity needs on the ships.

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