**MarCom**

PIANC WG159

# RENEWABLE ENERGY FOR MARITIME PORTS

# Terms of reference

## 1. Introduction and historical background

**Many ports are located where they have opportunities for development of renewable energy generation, by using existing or future port infrastructure and by taking advantage of their coastal locations. This Working Group has the aim of producing guidance and advice for port planners when considering the feasibility of installing sources of renewable energy.**

**At present, there are three mainstream forms of renewable energy which can be directly connected to maritime port infrastructure:**

- wind energy;
- solar energy;
- ocean energy (tidal energy; marine current energy; wave energy).

**Geothermal energy could also be considered.**

See Annex 1 for more detailed descriptions of these items.

## 2. Objective of the report

The report should focus on these major items:

- a critical review of the current state-of-the-art in the field of renewable energy devices which can be implemented with or within port infrastructure (with a selected and commented list of case studies);
- to provide general criteria to assess the overall potential renewable energy which can be harvested in the whole port area, with the purpose of reaching a reasonable share of the yearly energy consumptions of port infrastructure with "$CO_2$ free" solutions;
- to provide general advice for the implementation of both commercial and experimental projects related to the direct connection and/or integration of renewable energy devices to maritime port infrastructure, taking into account:
    - port engineering aspects (navigation and hydraulic aspects; structural, environmental and operational constraints),
    - electrical aspects (cabling, connection to the grid),
    - economic and financial aspects, efficiency of the systems.

### 3. Earlier reports to be reviewed

There are no specific earlier PIANC reports in this field of interest. However, liaison and coordination should be maintained with the ongoing WG 150 on “Green ports” which, however, is not directly dealing with the proposed item.

### 4. Matters to be investigated

The report should focus on the current problems, challenges and goals to be properly faced in the next future in the field, underlining opportunities and providing general technical advices.

### 5. Method of approach

Collection of all the useful information and documents. Some significant case studies should be briefly introduced and commented.

### 6. Suggested final product of the Working Group

Technical report providing an overview of the discussed matter, pointing out main principles, opportunities, critical aspects and general technical advices. Presentation of a set of selected case studies (including “lessons learned” from them).Possible extension to inland navigation and recreational ports should be mentioned, unless it seems possible to treat it within the scope of the working group.

### 7. Desirable disciplines of the members of the Working Group

Governmental managers, port authorities managers, port planners, port designers, specialized professors, energy managers of main contractors, renewable energy experts and environmental experts. Cooperation with IAPH should be encouraged by means of a joint WG.

### 8. Relevance for countries in transition

The report could have an extremely meaningful added value for countries in transition, based on the fact that they truly have a significant need of “know-how” in this field, in the light of an environmentally sustainable development of port infrastructure.

**Annex 1**

## Wind energy

Airflows can be used to run wind turbines. Modern wind turbines range from around 600 kW to 5 MW of rated power, although turbines with rated output of 1.5–3 MW have become the most common for commercial use; the power output of a turbine is a function of the cube of the wind speed, so as wind speed increases, power output increases dramatically. Areas where winds are stronger and more constant, such as offshore and high altitude sites, are preferred locations for wind farms. Typical capacity factors are 20-40%, with values at the upper end of the range in particularly exposed sites, such as maritime and offshore sites.

Globally, the long-term technical potential of wind energy is believed to be five times total current global energy production, or 40 times current electricity demand. This could require large amounts of land to be used for wind turbines, particularly in areas of higher wind resources. Offshore resources experience mean wind speeds of ~90% greater than that of land, so offshore resources could contribute substantially more energy.

Wind power is renewable and produces no greenhouse gases during operation, such as carbon dioxide and methane.

**Specific problems should be mentioned and discussed: storage; random nature of this kind of energy; costs of connection to the grid.**

## Solar energy

Solar energy is the energy derived from the sun through the form of solar radiation. Solar powered electrical generation relies on photovoltaics and heat engines. A partial list of other solar applications includes space heating and cooling through solar architecture, daylighting, solar hot water, solar cooking, and high temperature process heat for industrial purposes.

Solar technologies are broadly characterized as either passive solar or active solar depending on the way they capture, convert and distribute solar energy. Active solar techniques include the use of photovoltaic panels and solar thermal collectors to harness the energy. Passive solar techniques include orienting a building to the sun, selecting materials with favorable thermal mass or light dispersing properties, and designing spaces that naturally circulate air.

Photovoltaic panels could be implemented on roofs of buildings (for instance on sheds).

## Ocean energy

Also referred to as marine renewable energy, it refers to the energy carried by ocean and sea waves, tides and currents. This energy can be harnessed to create electricity to power homes, ports, transport and industries.

The term "ocean energy" encompasses tidal energy, marine current energy and wave energy harvested from oceans, seas, and, in general, other large bodies of water (like large lakes).

The oceans have a tremendous amount of energy and are close to many if not most concentrated populations. Many researches show that ocean energy has the potentiality of providing for a substantial amount of new renewable energy around the world.

Tidal energy is a form of hydroenergy that converts the energy of tides into electricity or other useful forms of power. Tidal energy exists as potential energy (tidal head energy) and kinetic energy (tidal stream energy). The first large-scale tidal power plant (the Rance Tidal Power Station) started operation in 1966.

Although not yet widely used, tidal energy has potential for future electricity generation. Tides are more predictable than wind energy and solar power. Among sources of renewable energy, tidal power has traditionally suffered from relatively high cost and limited availability of sites with sufficiently high tidal ranges or flow velocities, thus constricting its total availability. However, many recent technological developments and improvements, both in design (e.g. dynamic tidal power, tidal lagoons) and turbine technology (e.g. new axial turbines, crossflow turbines), are suggesting that the total availability of tidal power may be much higher than previously assumed, and that economic and environmental costs may be brought down to competitive levels.

Marine current energy, is a form of energy based on the harnessing of the kinetic energy of marine currents (tidal currents and non tidal ones). A 2006 report from US government agency Department of the Interior estimates "… that capturing just 1/1,000th of the available energy from the Gulf Stream, which has 21,000 times more energy than Niagara Falls in a flow of water that is 50 times the total flow of all the world's freshwater rivers, would supply Florida with 35% of its electrical needs."

Although not widely used at present, marine current energy has an important potential for future electricity generation. Marine currents are more predictable than wind energy and solar power.

A 300 kW full-scale plant installed by Marine Current Turbines (MCT) has been operating at Lynmouth, Devon (UK) since May 2003. Although this serves as a prototype for tidal systems such as SeaGen, MCT has also been planning deep sea marine current systems, which could be constructed in large farms and thus use economies of scale both in construction and maintenance and in the infrastructure for bringing the electricity to shore.

Wave energy is the transport of energy by ocean surface waves (short and long waves).

Wave power generation is not currently a widely employed commercial technology although there have been attempts at using it since at least 1890. The world's first commercial wave farm is based in Portugal, at the Aguçadoura Wave Park, which consists of three 750 kilowatt Pelamis devices.

Nowadays, wave power devices are generally categorized by the method used to harvest the energy of the waves.

They can also be categorized by location and power take-off system. Locations are shoreline, near shore and offshore.

Method types are: single point absorber or buoy; surfacing following or attenuator, oriented parallel to the direction of wave propagation; terminator, oriented perpendicular to the direction of wave propagation; oscillating water column (OWC); overtopping devices.

Types of power take-off include: hydraulic ram, elastomeric hose pump, pump-to-shore, hydroelectric turbine, air turbine, and linear electrical generator. Once the wave energy is harvested at a wave source, power must be carried to the point of use or to a connection to the electrical grid by transmission power cables.