Specific country information for Greece

Aquatic Renewable Energy Technologies (Aqua-RET)
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1. Country resource

The wave resource available in Greece is limited, despite having a coastline greater than 16,000 km on the Aegean and Ionian Seas. Wind over the Aegean Sea, in a North-South direction, generates an intense wave climate with the potential for 4–11 kW/m annual average power [1], [2]. There are certain 'hot spots' (e.g. Crete), as a result of the complex island terrain. Recent measurements and theoretical studies [3], [4] provide more detailed information on the wave climate in the Aegean.

Greece is not significantly affected by tides. Sea levels are more likely to be affected by wind pressure. The spring tide in Greece varies from 10 cm to 0.8m. The greatest spring rises occur in the Gulf of Volos and the Gulf of Evia. The only strong tidal stream is located in the narrow channel between the Greek mainland and the island of Evia at Halkida, which may reach 7 knots. For small hydro developments, the best sites are located in the Central Greece and Macedonia and in the prefecture of Epirus. Also in north Peloponnesus there is potential for run-of-river schemes.

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1. Athanassoulis GA, Skarsoulis EK. Wind and wave atlas of the northeastern Mediterranean sea, GEN/OK-20/92, 1992.
2. Pontes MT, Athanassoulis GA, Barstow S, Bertotti L, Cavaleri L, Holmes B, et al. The European Wave Energy Resource. 3rd EWEC, Patras, Greece, 1998
3. Cavaleri L, Athanassoulis GA, Barstow S. Eurowaves: a user-friendly approach to the evaluation of nearshore wave conditions. 9th ISOPE, Brest, France, 1999.
4. T.H. Soukissian, G.Th. Chronis and K. Nittis , POSEIDON: Operational marine monitoring system for Greek seas. Sea Technology **40** 7 (1999).

2. Development and testing

2.1. Research and development institutions and facilities

Greece is a leader in the EU for the performance of theoretical studies and experiments into renewable energy sources. R&D is conducted in universities and CRES (the Centre for Renewable Energy Sources), which has participated in many R&D projects, funded both by the EU and national government.

The National Technical University of Athens is carrying out research into wave resource modelling, specifically for wave energy schemes. This may be relevant to offshore wind projects for assessing the wave climate. The University is also conducting research into mechanical parts of devices for underwater use, as well as for grid connection. The Department of Environment of the University of the Aegean is active in the field of marine energy systems for applications in islands.

In the private sector, Wave Energy S.A. is developing the Wave Energy Point Absorber. It has completed full scale tests in depths of 10-20 metres and has plans to place the devices in greater depths. It has patented a device for the production of electricity and drinking water from wave energy.

DAEDALUS Informatics Ltd is engaged in worldwide research on the exploitation of marine energy, and is currently promoting an advanced hybrid of a wave and wind multipurpose system.

2.2. Technology and design testing facilities

In Greece there are no dedicated facilities at which aquatic renewable technologies can be tested, such as the EMEC or WEC facilities in the UK and Portugal, respectively.

The only body in Greece that may have adequate capacity for this type of facility is the Hellenic Centre for Marine Research (HCMR). The Centre was set up to integrate government-funded marine science research in Greece, integrating the former National Centre for Marine Research and the Institute of Marine Biology of Crete, together with their respective field stations. HCMR enjoys top-level scientific support from its two research vessels, a 2-man submersible, and three deepwater ROVs. Each can be chartered for work on route cabling, port authority works, hardware testing, recovery of underwater objects, and archaeological services. The Institute of Aquaculture at HCMR hosts a number of land based indoor and outdoor facilities (e.g. the Faros field station), and an experimental sea farm in Souda bay.

Certain tests on aquatic renewable technologies could be conducted at the facilities of CRES or at the Department of Naval Architecture and Marine Engineering of the NTUA, although this would be suitable only for small scale apparatuses.

2.3. Pilot zones and trial projects

The latest major legislative action related to renewable energy exploitation in Greece is the national special spatial plan for renewable energy sources, which is now being prepared by the Ministry of Environment, Physical Planning and Public Works. The first phase of the public consultation concluded in 2007. A new phase of public consultation has commenced and will last until the end of 2008. The legislation aims to prioritise renewable energy and set specific parameters on the eligibility of renewable energy projects nationwide.

The special spatial plan for renewable energy makes no specific reference to aquatic renewable energy, other than making note of small hydro power plants and onshore wind farms.

There are no officially designated areas for pilot zones or for the encouragement of early-stage aquatic renewable technologies. Such zones do not exist even for aquaculture, which is the main aquatic industry in Greece.

3. Power use and transmission

3.1. Power use options

Aquatic renewable energy power plants are particularly suitable for delivering electricity to the large number of islands (i.e. more than 3.000) which are supplied by power stations that use expensive imported diesel fuel. The high cost of electricity in the islands could make wave energy competitive against conventional power generation. Onshore wind energy has already proven its feasibility in the region, and is supported by the government and private investors.

Most Aegean islands host autonomous electricity networks. The available potential for wind, solar and wave energy projects is much greater than the portion that could be absorbed by the local grid. A large quantity of the energy produced there could be transferred to the main grid in conjunction with the appropriate grid interconnections.

Priorities for new energy projects in the island networks include the following:

- the exploitation of renewable energy potential using storage technologies (e.g. wind/pumped hydro-storage, hydrogen production by wind or waves);
- the production of potable water using renewable energy powered desalination technologies;
- alleviating peak loads with renewable energy, for example in the summer season.

3.2. Grid network

The areas of high renewable energy potential include the Aegean islands, Southern Euboea, Eastern Peloponnese, and Thrace. They have already attracted a number of investors. These usually sparsely populated areas have inadequate power transmission infrastructure constructed before renewable energy emerged as a viable option. On mainland areas with high wind potential, investment capabilities have been restricted due to low feed-in capacity of the local grids. Similar restrictions on the islands are hampering further renewable energy penetration.

Key programmes to reinforce existing power transmission infrastructure are currently being implemented in southern Euboea, south-eastern Peloponnese, and eastern Macedonia-Thrace. The Ministry of Development, in cooperation with the Public Power Corporation (PPC), prepared a tender for an electricity interconnection project involving the installation of an undersea electricity cable, which will connect all Cycladic islands. These are a group of islands in the Aegean Sea, several of which may be interconnected with the mainland, such as the city of Lavrio in Attiki. The interconnection will permit the development of new wind farms and other renewable energy projects on the islands, in order to transfer their capacity to the mainland.

3.3. Grid connections for aquatic renewables

To have the right to apply for connection to the grid, a renewable energy project developer must secure a production license, or an exemption for the requirement, and the environmental terms approval.

The contract for connection with the grid must be signed by the producer and the operator of the grid (i.e. Public Power Corporation - PPC), and the Power Purchase Agreement sale contract must be signed by the producer and the manager of the system (i.e. HTSO for the mainland or PPC for the islands).

4. Industry and skills

4.1. Manufacturing capacity

In Greece there is a clear trend towards wind and solar energy, both grounded in strong scientific and technological backgrounds. There is a growing industry sector in renewable energy technologies and installations which is favoured by the investment community. The solar water heaters manufacturing branch is the largest exporter of such systems in the EU.

There are a number of companies active in the field of studying, designing, and manufacturing electro-mechanical equipment, production equipment, building facilities, and the surrounding grounds of an industrial plant. The Greek steel industry is now involved in wind turbine tower manufacturing.

In light of the long held Greek tradition of shipbuilding and ship-repairing activities, there is clearly strong capacity and the relevant facilities for manufacturing devices, support structures, and other infrastructure work required for aquatic renewable energy development.

4.2. Support facilities and vessels

In Greece more than 80% of all industrial activities are located on the coast. These are industries that need water as part of their production process, or need water access for transportation purposes. Due to the coastal location of many major urban centres, to the geographic pattern of the major road transport axis from Patras to Kavala, and to the vicinity of the Greek coastline for geo-morphological reasons, the traditional role of shipping in transport of industrial products is important.

Harbours are predominant features nationwide, with Piraeus and Thessaloniki being the most important. Each island has its own harbour. Some islands, particularly those where tourism has not been developed, are lacking basic infrastructure, services and communication channels. Integrated development investment programmes, aim to correct these weaknesses.

Greece has the largest ship ownership the world, and Greek run companies control more than 25% of the world's fleet. Due to this tradition, ships and vessels are available that could be used for the installation of aquatic renewable energy projects, such as barges, harbour tags, floating cranes, but also factory ships, floating drills and excavators.

4.3. Workforce

In Greece there are many qualified engineers and other scientists with energy related post-graduate or graduate qualifications that may be available to support the development of aquatic renewable energy. Most have an understanding on the basics of energy production and transmission, but may not have all the qualifications that specific aquatic technologies require. Specialised training in new technologies issues should be a priority action for the country.

There are many skilled technicians working in the shipbuilding and ship-repairing industries, and this workforce could be conversant in the basics of technical works related to the construction of aquatic renewables plants or the manufacturing of devices. Even specialised divers exist for the necessary underwater works.

There is generally a lack of expertise at the local level, and sole reliance on the local workforce for the maintenance and operation of plants could cause significant operational problems. This is usually underestimated, and for financial reasons, the use of experienced personnel is bypassed. Also, the use of local workforce may be beneficial in order to minimise local reactions and boost the social benefits of the installations.

4.4. Educational institutes

CRES (Centre for Renewable Energy Sources) is the national co-ordination centre for renewable energy activities (e.g. RES, RUE, energy saving) and has nearly 20 years experience in the design and organisation of specialised courses in every aspect of renewable energy technologies. Along with other agencies, such as the Technical Chamber of Greece and the Hellenic Association of Mechanical and Electrical Engineers, CRES are organising yearly training courses and seminars on renewable energy technologies and energy efficiency issues for a variety of sectors. The courses, attended by engineers, students and other professional groups, provide specialised training on energy related issues customised for the trainees' level of understanding. These agencies are the most appropriate ones to train and develop the skills necessary for aquatic renewables.

There is more of a challenge in the training of specialised technicians that will have to undertake the technical part of the manufacturing of devices, construction and installation of aquatic renewables plants. The training structures available to provide training in this level, i.e. the Institutes of Vocational Training (IEK) and the Vocational Training Centres (KEK), do not currently offer the necessary courses, qualifications and infrastructures to carry out the specialised training for this group of workers.

5. Regulation

5.1. Leasing

In Greece, renewable energy project developers need to lease or purchase land or ask for permission to use sea-space. Coastal sea, rivers and lakes are in state ownership, as are the majority of lagoons.

According to Article 7 of Law 3468/2006, plants producing electricity from renewable energy sources and any project associated with their construction and operation, may be installed and operated on the foreshore, in the sea or on the sea-bed, where usage rights have been assigned pursuant to Article 14 of Law 2971/2001, as in force. Article 24 states that "concession of the right to use the foreshore, coastline, adjacent or nearby coastal area or seabed for carrying out works to install plants producing electricity from RES is permitted by means of decision of the Minister for Economic Affairs and Finance".

5.2. Consenting

After having purchased, leased or licensed the land or the sea-bed, the project developer should follow a certain procedure, clarified and described in Law 3468/06 and in a number of ministerial decisions that followed this Law (i.e. Δ6/Φ1/21691, Δ6/Φ1/5757, Δ5/Φ1/25968, Δ5/Φ1/13303).

- The required licenses for any energy related project are:
- The production permit; submission to RAE, issuing by the Minister of Development;
- Installation permit; issued as a decision of the General Secretary of the region within which the plant is established;
- Operation permit;
- Environmental permit;
- Planning authorities' license.

5.3. Environment

Aquatic renewables developments are unlikely to be permitted in protected wetland sites in Greece, such as the Ramsar wetlands which are of international importance. For any energy project, an environmental permit is required which has two parts: the Preliminary Environmental Assessment & Evaluation (PEAE) and the Environmental Terms Approval (ETA).

After submitting the stakeholder application for the Electricity Production License (EPL), RAE (http://www.rae.gr/) forwards the Preliminary Environmental Assessment Study to the Special Environmental Department (SED) of the Ministry for the Environment, Physical Planning and Public Works (YPEHODE, http://www.minenv.gr/). The decision for the PEAE is made by the under-Secretary of YPEHODE, after collection of approvals/opinions from relevant authorities such as the Ministries of Tourism, Culture, and Defence.

After completion of the PEAE and EPL procedure, the developer has to apply for the ETA, accompanied by the Final Study of Environmental Assessment, to the Department of Planning and Development in the region where the plant is located. It is then put forward to the SED of YPEHODE. The decision for the ETA is made by the Minister of YPEHODE or by the Secretary General of the region, after collection of approvals and opinions from relevant authorities (e.g. port authority).

5.4. Health and Safety

Apart from the general health and safety requirements for civil and infrastructure works, there are additional health and safety regulations with which a developer must comply, such as with those related to the electricity works for the installation, inspections, tests and repairs on electrical installations and equipment. Other regulations exist for the underwater works (e.g. investigations and recovery; repairs).

The website of the Hellenic Institute for Occupational Health and Safety (EL.IN.Y.A.E.) hosts a database that includes all European and Greek legislation dealing with health and safety at work. For any specific licenses required for carrying out “special works”, the competent authority is the Ministry of Employment & Social Protection.

6. Drivers of industry

6.1. Political drivers

The development of RES has been among the major energy policy lines of Greece for the last 15 years. It is seen as making an important contribution to the improvement of the Greek environmental indicators and, in particular, to the abatement of CO2 emissions. Legal and financial incentives are the tools of the government's strategy to support renewable energy technology (RET) investments.

A new law for the promotion of RES, **Law 3468/2006** "Production of Electricity from Renewable Energy Sources and High-Efficiency Cogeneration of Electricity and Heat and Miscellaneous Provisions" (Official Gazette A' 129/2006) was put in force from the 6th June 2006. This law sets a new standard for the production of electric energy from all types of renewable energy sources, cogeneration and marine energy.

The Law simplifies the licensing procedures and sets new financial and administrative incentives for the promotion of RES. Among others, Law 3468/2006 specifies that:

- the guaranteed market price is increased up to five-fold (for PV systems);
- the market time expands to 20 years;
- the licensing deadlines are being reduced;
- the special levy for the local administration organizations hosting such investments is raised to 3%.

The Law favours the formation of energy producing consortiums through a combination of subsidies and tax breaks. Especially for the power produced from PVs, the price of electricity from installed plants with a capacity up to 100 kW increases from the current price of €75 per MWh that stands for the rest of RES to 452 €/MWh, and to 502 €/MWh for islands not connected to the mainland's interconnected system.

The legislative framework for the licensing procedure, the methodology and the guidelines for obtaining grid connection for renewable energy projects have been further clarified and described in a number of ministerial decisions that followed the Law 3468/06.

6.2. Financial drivers

A major financial-support instrument providing substantial public subsidies to renewable energy investment projects is the "**National Development Law**" (3299/04), as amended by **Law 3522/06** - Article 37. This is the current investment incentives law that is applicable to enterprises, covering all sectors of economic activity in the country's regions.

Investments in renewable energy have a favoured status under the law as investments in high technology and environmental protection. Funding includes a subsidy for the total investment cost and can be 20%-60% depending on the region and the size of the company. Regions with high unemployment rates and low income per capita receive the highest investment subsidies.

Categories in the energy sector that are eligible for incentives under this law are:

- Cogeneration of electricity and heat.
- Energy production from renewables, especially wind and solar, hydroelectric, geothermal energy and biomass.
- Production of solid fuels from biomass, etc.

The Greek government also included renewable energy technologies in the actions of the **Operational Programme for Competitiveness (OPC)** of the 3rd Community Support Framework (CSF III; 2000-2006) for Greece, set out in order to facilitate the Greek economic growth. Renewable energy support is scheduled to continue for the 2007-2013 period with the approved O.P. "Competitiveness and Entrepreneurship".