9. Specific Country Information

Introduction

This section provides information on factors which impact the suitability for the development of aquatic renewable energy projects. Countries assessed include: Cyprus, Greece, Portugal, Romania and the UK. Information is provided in the native language of the respective country and in English.

A number of factors will affect the likelihood for a country to host an aquatic renewable energy sector.

- Resource – the aquatic renewable energy resource type.
- Development and testing – facilities for testing aquatic renewable energy devices.
- Power use and transmission – the markets for energy, and the quality and coverage of energy transmission facilities.
- Industry and skills – manufacturing capacity for aquatic renewable energy devices, a workforce with training and skills relevant to the aquatic renewable energy sector.
- Regulation – existence and quality of regulation governing deployment, operation and decommissioning of aquatic renewable energy projects.
- Drivers and industry support – incentives (public and private) to encourage development of the aquatic renewable energy sector.

Resource

The most important factor is the presence, or absence, of aquatic renewable energy resources.

For each AquaRET partner country (Cyprus, Greece, Portugal, Romania, UK), this section identifies the presence, or absence, of aquatic renewable energy resources. This assessment includes run-of-river, tidal impoundment, tidal stream, wave and offshore wind.

Maps are provided where possible to give a better understanding of where the resource is located.

Development and testing

This section provides information on the facilities available in Cyprus, Greece, Portugal, Romania and the UK for the support of innovative aquatic renewable energy technologies.

This includes sub-sections on:

- Research and development facilities – where innovative technology and new products for the aquatic renewable energy sector can be designed.
- Testing facilities – physical locations where prototype devices and innovative components can be tested to measure performance (e.g. wave tanks or open sea zones).
- Pilot zones – designated areas where installations of aquatic renewable energy projects are specifically encouraged.

Power use and transmission

Descriptions of aspects related to power transmission in Cyprus, Greece, Portugal, Romania and the UK. This includes the following sub-sections:

- Power use options – likely forms of energy outputs from aquatic renewable energy; an indication of the market to which energy will be sold. Some countries, for example, use aquatic renewable energy to provide power for desalination; others channel aquatic renewable electricity directly into the national electricity grid.
- Grid networks – the quality and coverage of the national power grid
- Grid connections – a summary of the process for obtaining a grid connection permit, with details of the body in charge of this process.

Industry and skills

An indication of the resources available in Cyprus, Greece, Portugal, Romania and the UK for the development of aquatic renewable energy projects, including the following sub-sections:

- Manufacturing capacity – resources available for manufacturing aquatic renewable energy devices or their components (e.g. moorings, cables or substations).
- Support facilities and vessels – the availability (or lack) of sufficient, quality infrastructure to support aquatic renewable energy projects. This may include information on harbours, ports and ship availability.
- Workforce – the availability (or lack) of technically-trained people to support the development of aquatic renewable energy projects. Sectors of importance include specialists in construction, manufacturing, regulation and environmental science.

- Educational institutes – educational and vocational institutions available to train specialists.

Regulation

The main consents, licences or permissions required in Cyprus, Greece, Portugal, Romania and the UK to develop an aquatic renewable energy projects; some basic information on the process by which these are acquired. Sub-sections include:

- Leasing – the permissions necessary to buy or lease land or seabed on which to develop an aquatic renewable energy project.
- Consenting – the permissions necessary to develop an aquatic renewable energy project on a specific site.
- Environment – extra permissions needed, related to the environment, which may be required to develop an aquatic renewable energy project.
- Health and safety – extra permissions needed, related to health or navigation safety, which may be required to develop an aquatic renewable energy project.

Drivers of industry

An assessment of incentives in Cyprus, Greece, Portugal, Romania and the UK for the development of the aquatic renewable energy industry, with sub-sections on:

- Political drivers – political messages of support to the development of the aquatic renewable energy industry; this may include targets and objectives, general permissions, or pilot zones.
- Financial drivers – finance available to aid the aquatic renewable energy industry; this may include public revenue or grant support. Some basic information on the availability of private finance is also included.

9.1. UK

9.1.1. Country resource

The wet renewable resources of the United Kingdom are widely distributed.

The following link takes the user to the Atlas of UK Marine Renewable Energy Resources.

http://www.renewables-atlas.info/

This Atlas has information on wave, tidal stream, and offshore wind resources.

The best tidal stream resource is found in areas such as: the Pentland Firth, Orkney, west of Argyll and Bute, around Anglesey, the Severn Estuary, close to the Isle of Wight, around Norfolk and around the Humber. Generally speaking, the best wave resources are to be found in areas such as: the West of Scotland's Hebrides, Shetland and Orkney Islands, and west of Cornwall.

Existing offshore wind farm developments have clustered around resource areas off Lancashire and Cumbria, east of the Thames Estuary, north of Norfolk, and east of Lincolnshire, as well as the Moray Firth in Scotland. The next phases of offshore wind development will be concentrated in the new areas of seabed to be leased by The Crown Estate. These are indicated in Figure 1 as pink areas.

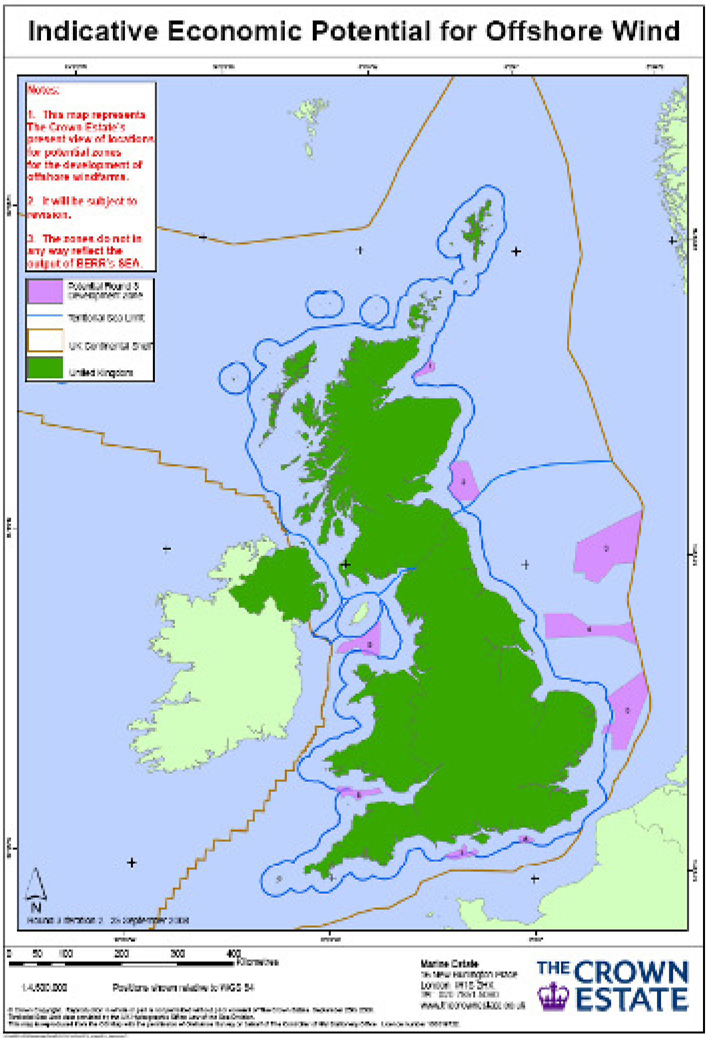

Figure 1 – Map of Round 3 areas for Offshore Wind, copyright The Crown Estate

The Sustainable Development Commission has reported on the tidal range resources in the UK, noting the top UK sites for tidal range resource being the Duddon, Mersey, Wyre, Conway and Severn Estuaries.

Table 1: Top UK sites for tidal power

Tidal range sites		Tidal stream sites		
Site name	Resource (TWh/year)	Site name	Area	Resource (TWh/year)
Severn	17	Pentland Skerries	Pentland Firth	3.9
Mersey	1.4	Strøma	Pentland Firth	2.8
Duddon	0.212	Duncansby Head	Pentland Firth	2.0
Wyre	0.131	Casquets	Alderney	1.7
Conwy	0.06	South Ronaldsay	Pentland Firth	1.5
		Hoy	Pentland Firth	1.4
		Race of Alderney	Alderney	1.4
		South Ronaldsay	Pentland Firth	1.1
		Rathlin Island	North Channel	0.9
		Mull of Galloway	North Channel	0.8

Figure 2 – Table 1 – "Turning the Tide" Sustainable Development Commission, copyright Sustainable Development Commission

Some of the best run-of-river resource in the UK is located in North West Scotland. The Forum for Renewable Energy Development in Scotland (FREDS) group will shortly publish a report on Scotland's hydro resources, which will be available here: http://www.scotland.gov.uk/Topics/Business-Industry/Energy/19185/17613

9.1.2. Development and testing

9.1.2.1. Research and development institutions and facilities

The UK has a strong R&D base for wave and tidal stream technologies. Research has been carried out by universities across the country, and several universities have developed their own devices (e.g. the Salter Duck developed at Edinburgh University in the 80s). The SUPERGEN Marine consortium is a key research programme, funded by the UK Government's Engineering and Physical Sciences Research Council (EPSRC), which has had two phases. The second, now active, aims to "increase knowledge…of device-sea interactions… from model-scale… to full size," and involves Edinburgh University, Heriot Watt University, Lancaster University, University of Strathclyde, and Queen's University Belfast. A "landscape" of UK R&D into marine renewables is available from the UK Energy Research Centre (http://ukerc.rl.ac.uk/Landscapes/Marine.pdf).

There have been a number of offshore wind R&D programmes in the UK. One notable programme is the SUPERGEN Wind consortium, also funded by EPSRC, and founded in 2006. The aim of SUPERGEN Wind is to "undertake research to improve the cost-effective reliability and availability of existing and future large-scale wind turbine systems in the UK". A programme of research has been undertaken by the UK Government's Marine Renewable Energy Research Advisory Group, to investigate impacts of offshore wind. Research through this programme has focused on environmental and navigation impacts, and details can be found on http://www.berr.gov.uk/energy/sources/renewables/policy/offshore/research-advisory/page22590.html The COWRIE (Collaborative Offshore Wind Research Into the Environment) is a charity which directs research into the environmental impacts of offshore wind. Details of COWRIE projects can be found on http://www.offshorewindfarms.co.uk/Pages/Projects/.

9.1.2.2. Technology and design testing facilities

There are a number of facilities available in the UK at which aquatic technology can be tested.

The European Marine Energy Centre (EMEC) is based in the Orkney Islands in Scotland. Founded on the basis of a 2001 recommendation of the House of Commons Science and Technology Committee, EMEC has been funded by a number of public organisations. EMEC aims to help marine energy technologies progress from the prototype stage to commercial readiness. This is primarily through the provision of grid-connected berths in which developers can assess device performance, in line with internationally recognised standards. The Centre offers a wave device test site with four berths, and a tidal stream site with five berths. Research into the environmental impacts of devices is also possible at EMEC. For more information on the services offered by EMEC, please see the organisation's website: www.emec.org.uk.

NaREC, the New and Renewable Energy Centre, is another key UK testing facility for aquatic renewable technology. It is based in Blyth, Northumberland, and was established in

2002 with funding from UK and EU public sources as a Centre of Excellence for the design, deployment and commercialisation of sustainable energy forms. NaREC is involved in the development of electricity networks which have capacity for new renewable generation. The services provided by NaREC include: wind turbine blade and materials testing; wave and tidal energy prototype development; marine energy resource and market assessment; and high voltage system design. NaREC also offers a controlled saltwater testing facility for testing of subsea equipment and the "EnergyLINK lab" for testing the impacts of micro- and medium-scale generation on electricity networks. For more information on NaREC's services, please see the organisation's website: http://www.narec.co.uk/.

The UK hosts a number of marine tanks and wind tunnels for equipment testing, operated by Universities as well as commercial companies. The UK Energy Research Centre's Marine Energy Landscape is a useful document outlining these types of facilities. Please see the: http://ukerc.rl.ac.uk/Landscapes/Marine.pdf.

9.1.2.3. Pilot zones and trial projects

Deployment of early-stage aquatic renewable technologies has been directed towards certain geographic areas of the UK, although the UK Government has not designated any "pilot zones" per se.

The European Marine Energy Centre (EMEC) offers testing berths for full-scale prototype wave and tidal stream devices. These berths are located in the Orkney Islands in Scotland. The wave test berths are located off Billia Croo on the Orkney mainland. The tidal stream site is at the Fall of Warness, west of the island of Eday. These berths are fully grid-connected, though basic environmental and planning consents must be attained for the connection of individual devices to the berths.

In 2007, the UK Government gave planning consent for the 'Wave Hub' project. The project aims to provide a grid connection point for wave energy devices 16km off the coast of Hayle, Cornwall in South West England. The hub caters for the testing of devices prior to commercial deployment, and will be located in water roughly 50m deep. Wave Hub is expected to have four power connection points, and four developers have already contracted to use these berths. The project aims to ensure that berths are subject to simplified consenting requirements. Installation of the Wave Hub connection point is expected in Spring 2010. For more information about the project, please see the Wave Hub website: http://www.wavehub.co.uk/.

While the location of emerging technology projects may be determined initially by testing and pre-commercial deployment facilities, the geographical location of more mature energy projects in the UK may be influenced by proposals from The Crown Estate. The Crown Estate is a UK property institution which has historically managed the property of the Crown (royal family), and owns the majority of the UK seabed. The Crown Estate has suggested "zones" for the development of offshore wind farms in the UK. For more information on these zones, please see: http://www.thecrownestate.co.uk/offshore_wind_energy.

There are no designated "pilot zones" for the development of tidal barrage or run of river technologies in the UK, though there is a feasibility study being conducted into the concept of a tidal barrage in the Severn Estuary.

9.1.3. Power use and transmission

9.1.3.1. Power use options

Energy from aquatic renewable sources in the UK is likely to be used in the form of electricity, on a large-scale, with projects feeding in to the local distribution and national transmission networks. There are a number of hurdles to be overcome in connecting offshore projects to the Grid network.

Run of river schemes may be used at the micro-generation scale, generating electricity for the personal consumption of householders or communities. Examples of a number of micro hydropower schemes which have been installed in Scotland are available on the following website: http://www.energysavingtrust.org.uk/schri/community/projects.cfm

There is increasing interest in the UK in medium scale hydro developments of 100 kW – 1MW capacity. The Forum for Renewable Energy Development in Scotland (FREDS) is currently carrying out a study into the potential hydropower resource in Scotland, including run of river schemes. This is due to be published in 2008, and will be available on the FREDS website. Offshore wind, wave, tidal stream and tidal barrage resources are less likely to be utilised at the microgeneration scale, for distributed or personal use.

The use of offshore wind, wave, tidal or run-of-river schemes to generate electricity, which would then be converted to heat, is a possibility. This option may be attractive in the future to island or remote communities where access to the gas network, or to a steady supply of biomass, is constrained. More novel forms of aquatic renewables may be used to generate heat directly. One good example of this, which is being investigated in the UK, is the use of macro-algae (or seaweed) as a fuel for anaerobic digestion. Anaerobic digestion would convert the seaweed into biogas, which could then be combusted to provide heat. In the UK, the Scottish Association for Marine Science (SAMS) is currently conducting research into this area. See their website at http://www.sams.ac.uk/.

9.1.3.2. Grid network

The UK national electricity network is called the National Grid. It is composed of the 'transmission network', which is a national network carrying high voltage electricity, and the 'distribution networks', which are regional networks carrying medium- and low-voltage electricity from the transmission network to consumers.

There are certain hurdles to be overcome on grid issues in order for the UK to fully maximise the potential of its aquatic renewable resources. These difficulties relate to grid infrastructure and capacity. The UK electricity grid was built for a system which relied on large-scale, centralised generation units. There have been delays in investing and approving new upgrades which would help the system cope with the often decentralised and remote nature of renewable generation.

The UK's National Grid website shows a simplified map of the UK transmission network[1]. There are large parts of the UK with a lack of significant grid coverage. Significantly for aquatic renewables, this includes the North and West Coast and Islands of Scotland, and the west coast of Wales. Due to infrastructural constraints and regulatory changes, there is more than 10GW of predominantly onshore renewables in Scotland awaiting connection.

Fortunately, there has recently been discussion on possible solutions to these difficulties. This includes thinking on the potential for large scale subsea cables, which would allow for the connection of remote aquatic renewable generation to centres of demand in the UK and abroad. The Crown Estates have conducted a feasibility study[2] for such a cable. Considerable effort is now being taken to reinforce existing networks, including the upgrade of the Beauly-Denny transmission line, for instance.

9.1.3.3. Grid connections for aquatic renewables

The UK national electricity network is called the National Grid. It is composed of the 'transmission network', which is a national network carrying high voltage electricity, and the 'distribution networks', which are regional networks carrying medium- and low-voltage electricity from the transmission network to consumers.

In England, the transmission network is owned, operated and developed by the National Grid in England. In Scotland, the transmission network is operated and owned by subsidiaries of Scottish and Southern Energy and ScottishPower subsidiaries in Scotland. In Northern Ireland the transmission system is operated by the System Operator for Northern Ireland (SONI). National Grid also acts as the System Operator, setting the "rule book", within which transmission operators must work.

[1] http://www.nationalgrid.com/annualreports/2006/05_opfinrev/ukelecgastransmission.html

[2] http://www.thecrownestate.co.uk/east_coast_transmission_network_technical_feasibility_study.pdf

The distribution networks are operated by a variety of different companies, depending on geographic location – this map[3] shows the different distribution network operators across the UK.

The National Grid website offers advice on the necessary requirements to connect to the distribution or transmission systems here[4].

If a generator wants to connect an aquatic renewable project to the high voltage transmission system, they must contact National Grid. To get connected, they must enter into a "Bilateral Connection Agreement" with the National Grid. This agreement will ensure that the generator complies with a number of codes. The generator must also pay a number of charges, including:

- the Transmission Use of System Charge;
- the Balancing Services Use of System Charge; and,
- the Connection Charges.

For more information on the above codes, charges and on how to apply, please see the National Grid website[5].

If a generator wants to connect an aquatic renewable project to the lower voltage distribution system, they should in the first instance contact their District Network Operator (see this map for the relevant company). However, if the generator would also like to export electricity from the distribution system to the transmission system, they must then contact National Grid. In either case, the generator will most likely enter into a Bilateral Embedded Generation Agreement. In Scotland, another form of agreement is open for generation projects with larger capacity. For more information on the agreements and associated charges, please see the National Grid website[6].

[3] http://www.nationalgrid.com/uk/Electricity/AboutElectricity/DistributionCompanies/

[4] http://www.nationalgrid.com/uk/Electricity/GettingConnected/

[5] http://www.nationalgrid.com/uk/Electricity/GettingConnected/TransmissionConnected/

[6] http://www.nationalgrid.com/uk/Electricity/GettingConnected/dnoConnected/

9.1.4. Industry and skills

9.1.4.1. Manufacturing capacity

In recent decades, the UK's economic strategy has focused on growing a 'knowledge economy', based on the service sector. This has been in the context of competition with emerging economies leading to a decline in heavy industry.

However, though the number of UK jobs in manufacturing has fallen over the past decade, there is evidence of a shift to a smaller manufacturing industry fabricating higher-value products. Additionally, the number of jobs in construction has risen over the last decade, and government economic development agencies now recognise that demand for renewable energy devices and infrastructure offers growth opportunities for the manufacturing sector. For more information on regional manufacturing capacity, the following websites may be of use:

- Futureskills Scotland
  - (http://www.scotland.gov.uk/Topics/Economy/labour-market)
- England's RDAs (Regional Development Agencies)
  - (http://www.englandsrdas.com/)
- Welsh Development Agency
  - (http://new.wales.gov.uk/topics/businessandeconomy/?lang=en)
- Invest Northern Ireland
  - (http://www.investni.com/)

There are several facilities across the UK capable of manufacturing renewable device components. This includes: the Vestas Celtic facility for wind turbine blade manufacture on the Isle of Wight and wind turbine tower manufacture at Campbeltown; the Fife Energy Park with facilities for marine and wind renewables fabrication; and the Camcal facilities for renewables device manufacture on the Isle of Lewis.

The UK has offshore engineering expertise due to its North Sea oil and gas industry. The skills from this industry will be, in many cases, transferable to the offshore aquatic renewables industry. For more information on these firms, please see the database maintained by the International Marine Contractors Association[7].

[7] http://www.imca-int.com/members/europeafrica/

9.1.4.2. Support facilities and vessels

The UK generally has quality infrastructure to support the development of aquatic renewable energy projects.

The national transport infrastructure is strong. There are 30 main airports operating domestically and internationally. The road and rail networks across the UK are of a good quality and coverage. For a detailed map of the UK rail network, also showing links to airports and ferry ports, please see the Network Rail website[8].

The UK has a good quality ports infrastructure, with the largest ports industry in Europe. For a map of the major ports in the UK, please see the UK Major Ports Group website[9].

One challenge for the UK aquatic renewable energy industry is difficulty in obtaining access to service and installation vessels. Anecdotal evidence suggests that vessel availability is limited due to high demand and the challenge of operating in the most energetic environments, and that vessel hire prices can be preclusive for pre-commercial projects.

9.1.4.3. Workforce

The UK has a skilled workforce, which could support the development of a large aquatic renewable energy industry. The following sections give more detail on the availability of specific skill sectors within the UK.

Manufacturing

The UK's economic strategy focuses on developing a 'knowledge economy', based on the service and innovation sectors. This has been in the context of competition with emerging economies leading to a decline in heavy industry. As such, there has been a shift in skills-training away from manufacturing industry. However, although the number of UK jobs in manufacturing has fallen over the past decade, there is evidence of a shift to a smaller manufacturing industry fabricating higher-value products.

Science and engineering

The number of jobs in construction has risen over the last decade, and government economic development agencies now recognise that demand for renewable energy devices and infrastructure offers growth opportunities for the manufacturing and construction sectors.

Skilled scientists and engineers have traditionally made up a high percentage of the UK's workforce. This is set to continue, with Government policy dictating that Britain should become "the most attractive location in the world for science and innovation." However,

8 http://www.nationalrail.co.uk/tocs_maps/maps/NationalRailSchematicMapLarge.pdf

9 http://www.ukmajorports.org.uk/

research[10] published through the Office for National Statistics suggests that though there has been recent growth in the numbers of science and technology graduates in the UK, this has masked a decrease in the number of engineering graduates.

Regulation

In terms of the UK's regulatory skill set, recent research[11] by the UK Parliament's 'Communities and Local Government Committee' highlights a 'drastic shortage in planning officers' as well as a shortage of expertise on renewable energy within the whole planning system. This shortage may not affect offshore wind, wave, tidal stream and tidal barrage projects to a great extent, because these types of projects are consented by central government, rather than local planning officers. The shortages of planning officers generally and planners with experience of renewables more specifically, may, however, affect run-of-river projects.

9.1.4.4. Educational institutes

The UK has a wealth of educational institutes at which people may train for a career in the aquatic renewable industry.

Aquatic Renewable Energy - Science and Engineering

The UK Energy Research Centre produces a series of "Energy Research Landscapes" which outline the main research facilities and activities in the UK relating to energy. This includes an outline of educational facilities, and highlights their research interests and capabilities.

Wave and tidal energy – The Marine Energy Research Landscape was produced in 2007[12].

Wind energy – The Wind Energy Research Landscape was produced in 2008 [13].

Hydropower (run-of-river) – Unfortunately, there are no plans to publish a hydropower research landscape. Some of the institutions which may offer training on, and conduct research into, hydropower-related subjects include:

- The Hydraulics Research Group, Queen's University, Belfast
- Environmental Fluids and Coastal Engineering, University College London
- The Maritime Environmental and Water Systems Group, University of Liverpool

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[10] http://www.statistics.gov.uk/CCI/article.asp?ID=1474&Pos=5&ColRank=2&Rank=288

[11] http://www.publications.parliament.uk/pa/cm200708/cmselect/cmcomloc/517/517i.pdf

[12] http://ukerc.rl.ac.uk/Landscapes/Marine.pdf

[13] http://ukerc.rl.ac.uk/Landscapes/Wind.pdf

Manufacturing & Technical

The UK Government runs a programme of 'Modern Apprenticeships', through which employees are recruited with a participating employer, and are then offered on-the-job training while working towards National Vocational Qualifications. There are a number of Modern Apprenticeships in disciplines which would be of use for a career in the aquatic renewable energy industry, including: the Electricity Industry Apprenticeship; the Manufacturing Apprenticeship; the Electrotechnical Apprenticeship; Steel and Metals Industry Apprenticeship; and the Engineering Apprenticeship. For more information on Modern Apprenticeships, please see here[14].

Planning & Consenting

Recent research by the UK Parliament's Communities and Local Government Committee highlighted that although there had been a fall in the number of planning schools and planning students during the 1980s and the 1990s in the UK, there has been an increase in both since 2000. There are a number of planning courses available in the UK, graduates from which go on to work in public sector consenting, or in private sector planning consultancy. The Royal Town Planning Institute accredits planning courses in the UK, Ireland and Hong Kong. A list of these courses is available here[15].

Other

A large aquatic renewable energy industry will require not just engineers, manufacturers and regulators, but skilled people from a range of other professions such as project management, marketing, law and finance. The UK's universities rank among the best in the world for both arts and sciences degrees.

[14] http://www.apprenticeships.org.uk/

[15] http://www.rtpi.org.uk/item/178/23/5/3

9.1.5. Regulation

9.1.5.1. Leasing

In order to develop an aquatic renewables project in the UK, a developer must obtain rights to the land, sea-bed or river-bed sought.

Seabed

In the UK, the majority of the seabed out to 12 nautical miles from the coast is owned by an organisation called The Crown Estate. The Crown Estate is a UK property institution which has historically managed the property of the Crown (royal family) on behalf of the UK Government. The Crown Estate currently has the right to license renewable energy generation on the sea-bed from 12 nautical miles to the seaward extent of the UK Renewable Energy Zone out to 200 nautical miles from the shore. Additionally, the Crown Estate owns approximately half of the UK's estuary beds.

Most offshore wind, wave, tidal stream and tidal barrage projects will need to obtain a lease from the Crown Estate for the sea- or estuary-bed required for their developments. In some cases, such as for offshore wind, The Crown Estate will designate certain areas of the sea specifically for development purposes. Where this is not the case, developers will need to enter into individual discussions with The Crown Estate.

For more information on The Crown Estate and leasing arrangements, please see the organisation's website[16].

Land

Developers of aquatic renewables projects will often need to obtain rights to land in order to progress their projects – this could be for the laying of cables on the shore, or for the siting of a substation, for instance. Project developers must enter into discussions with the current landowner to obtain the necessary rights, whether through complete purchase of the land, or through leasing arrangements. The landowner may be a private individual, company or public organisation.

River-bed

Developers of run-of-river or tidal barrage projects will need to obtain rights in order to progress their projects. The Crown Estate own approximately half of the tidal river beds in the UK, while the other half will be owned by private individuals, private companies or public organisations.

[16] http://www.thecrownestate.co.uk/marine

9.1.5.2. Consenting

In the UK, planning laws mean that anyone who wishes to 'develop' land must obtain permission before doing so, even if they own the land they wish to develop.

A developer of a renewable energy project must usually obtain this permission, or planning consent, for their project before undertaking development activities. For aquatic renewable energy installations, these will be controlled primarily through the Electricity Act 1989.

Section 36 of this Act states that applications for planning permission for offshore renewables projects (including wind farms, wave and tidal stream farms) or water-powered generation projects (including hydroelectric plants) with greater than 1 MW capacity will be dealt with by central government, rather than local planning officials. Planning permission granted through this Act is often referred to as "s36 consent".

Onshore aquatic renewable energy projects (e.g. hydropower) smaller than 1 MW is dealt with by local planning officials. An application for planning permission would have to be made in this case to the local planning authority. The Planning Portal website[17] will direct you to the relevant local authority.

The consenting arrangements for the offshore environment are currently under review by both the UK and Scottish Governments. The UK and the Scottish Marine Bills, and the Planning Reform Bill, are likely to amend the consenting process, meaning that planning permission for offshore wind, wave, tidal stream and tidal barrage projects may be granted under different conditions, by a different branch of government. For large offshore wind projects in England, for example, it is likely that a new 'Infrastructure Planning Commission' will handle consents.

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[17] http://www.planningportal.gov.uk/wps/portal/genpub_DevelopmentPlans?scope=202

9.1.5.3. Environment

In order to develop an aquatic renewables project in the UK, in addition to a site lease and planning permission, there are two other licences a developer must obtain. These are a licence under the Food and Environment Protection Act 1985 and a licence under the Coastal Protection Act 1949. At the time of writing, these licences are awarded by branches of central government. Detailed information on the authorities with responsibility for these licences, as well as other extra requirements for the consenting of an aquatic renewables project, are available on the websites of the Department for Business, Enterprise and Regulatory Reform (wave and tidal stream[18]), and the Scottish Government[19].

The consenting arrangements for the offshore environment are now under review by both the UK and Scottish Governments. The UK and the Scottish Marine Bills, and the Planning Reform Bill, are likely to amend the consenting process, meaning that planning permission for offshore wind, wave, tidal stream and tidal barrage projects may be granted under different conditions, by a different branch of Government. One proposal, for instance in the Scottish Marine Bill, is that individual projects will not have to apply separately for planning permission and the two other licences, but will be assessed as a whole and given one licence per project. Please visit the relevant websites for detail on the progress of the UK Marine Bill[20], Scottish Marine Bill[21] and Planning Reform Bills[22].

9.1.5.4. Health and Safety

The Maritime and Coastguard Agency is the UK government agency responsible for implementing maritime safety policy. They have drawn up guidance for safety of navigation around offshore renewable energy installations, which is available here[23].

[18] http://www.berr.gov.uk/files/file15470.pdf

[19] http://www.scotland.gov.uk/Topics/Business-Industry/Energy/Energy-Consents

[20] http://www.defra.gov.uk/marine/legislation/index.htm

[21] http://www.scotland.gov.uk/Topics/Environment/Water/16440/marine-bill-consultation

[22] http://www.leaderofthehouseofcommons.gov.uk/OutPut/Page2036.asp

[23] http://www.mcga.gov.uk/c4mca/mcga07-home/shipsandcargoes/mcga-shipsregsandguidance/mcga-windfarms.htm

9.1.6. Drivers of industry

9.1.6.1. Political drivers

The UK Government, and the devolved authorities (Scottish Government, Welsh Assembly, Northern Irish Executive), have each expressed a willingness to see the growth of the renewable energy sector in the UK. The growth of the sector is perceived as holding benefits in terms of reducing greenhouse gas emissions, reducing the UK's dependence on imported energy, and creating job opportunities.

The UK was instrumental in pushing forward a European commitment to oblige the European Union to produce 20% of its energy (electricity, heat and transport fuels) from renewables by 2020. This commitment will be formalised in the EU Renewable Energy Directive, and the UK expects its own obligation to amount to 15% of energy from renewables by 2020.

Achieving the 15% will be a monumental task, as it now stands at just over 2% of primary consumption met by renewable energy in the UK. The aquatic renewable energy industry has been identified as key to enable the UK to meet its energy targets.

There sector is mentioned favourably in the UK Government's important Renewable Energy Strategy. As well as this, in late 2007, the UK Government announced plans to have 33GW of offshore wind energy around the UK, and is now conducting a Strategic Environmental Assessment (SEA)[24] into further 'rounds' of offshore wind licensing.

The Scottish Government has been particularly interested in the development of the wave and tidal stream sectors. It has helped to fund the European Marine Energy Centre[25] (EMEC, the first test centre for pre-commercial wave and tidal stream prototype device), and has pledged to support the deployment of 10MW wave and tidal energy by 2010.

9.1.6.2. Financial drivers

There is a range of public financial support mechanisms in place in the UK for the aquatic renewable energies.

Revenue

Revenue support for the renewable energy industry in the UK comes largely from the Renewables Obligation mechanism. This mechanism obliges electricity suppliers to provide a certain proportion of their supply from renewables, or else to pay a penalty. To prove their compliance, they must show the regulator Renewables Obligation Certificates (ROCs). These are purchased from generators of renewable electricity at a market price, with a

[24] http://www.offshore-sea.org.uk/site/index.php

[25] http://www.emec.org.uk/

generator able to sell 1 ROC for every MW-hour of renewable generation. The money from suppliers who pay a penalty ("buy-out price") is put into a communal fund (the "buy-out fund") and redistributed to those suppliers who did provide ROCs. The market price of a ROC is determined by a number of factors, including the 'brown' price of electricity, and the level of buy-out price.

At the time of writing, the UK and Scottish Governments are preparing to "band" the Renewables Obligation mechanism, so that generators of renewable electricity from emerging technologies will receive greater support than those who generate renewable electricity from mature technologies. In England & Wales it is proposed that generators of wave and tidal stream electricity will be able to sell 2 ROCs for every MWh of electricity they produce, while generators of onshore wind electricity will be able to sell only 1 ROC for every MWh. Under these same proposals, offshore wind would receive 1.5 ROCs per MWh while tidal barrage would receive 2 ROCs per MWh. Hydroelectric (including run-of-river) would receive 1 ROC per MWh for installations over 50kW capacity and 2 ROCs for installations over 50kW capacity.

At the time of writing, there is also an additional revenue support mechanism in Scotland called the 'Marine Supply Obligation' (MSO). This was put in place prior to discussions on banding the Renewables Obligation, and was developed in order to support the wave and tidal stream sectors. It is likely that the MSO will be removed, and wave and tidal stream sectors encouraged instead by a greater number of ROCs.

Other sources of funding

There are a number of grant support mechanisms in place for aquatic renewable technologies. These are largely in place for the more emerging technologies, such as wave and tidal stream energy. For more details on the most notable additional finance schemes please click on the following:

- Energy Technologies Institute – Offshore Wind Programme[26]
- Energy Technologies Institute – Marine Energy Programme[27]
- Environment Transformation Fund: Marine Renewables Deployment Fund[28]
- The Carbon Trust – Marine Energy Accelerator[29]
- The Saltire Prize[30]

[26] http://www.energytechnologies.co.uk/technology-programmes/current-programmes/offshore-wind/

[27] http://www.energytechnologies.co.uk/technology-programmes/current-programmes/marine-wave-and-tidal/

[28] http://www.berr.gov.uk/energy/environment/etf/marine/page19419.html

[29] http://www.carbontrust.co.uk/technology/technologyaccelerator/mea

9.2. Cyprus

9.2.1. Country resource

The Cyprus Meteorological Service conducted an investigation to assess the availability of offshore wind as a renewable energy resource. However, the results of the investigation are limited, based only on a very few, and some inadequate, locations for which the meteorological service processed data. For some locations, data was collected for 3 years, although measurements were taken only 10m above the water surface. Locations where wind farm developments have already been approved by the Cyprus Energy Regulatory Authority were not included in the assessment.

For other renewable energy resources, there have been no examinations to assess potential offshore resources, while run of river is virtually nonexistent in Cyprus.

9.2.2. Development and testing

9.2.2.1. Research and development institutions and facilities

There are at least 2 state-owned universities in Cyprus which offer degrees in engineering and relevant science fields related to renewable energy sources. However, neither has yet developed sophisticated research and development activities on renewable energy technologies because both departments are relatively new and technical operations only began last year.

Another private technical university officially opened last year and has only just started its operations as a university, having previously been designated a technical college, and has not yet specialised in research and development activities.

9.2.2.2. Technology and design testing facilities

Testing facilities for aquatic renewable energy resources are virtually non-existent in Cyprus. Most renewable energy resources have yet to be investigated and remain unexploited. Given their unknown potential it is unlikely that investment will be committed for testing facilities.

9.2.2.3. Pilot zones and trial projects

There are no pilot zones for the early-stage aquatic renewable technologies in Cyprus, as resource availability and potential have not yet been investigated. Changes in this area are unlikely in the near future.

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[30] http://www.scotland.gov.uk/Topics/Business-Industry/Energy/saltire-prize

9.2.3. Power use and transmission

9.2.3.1. Power use options

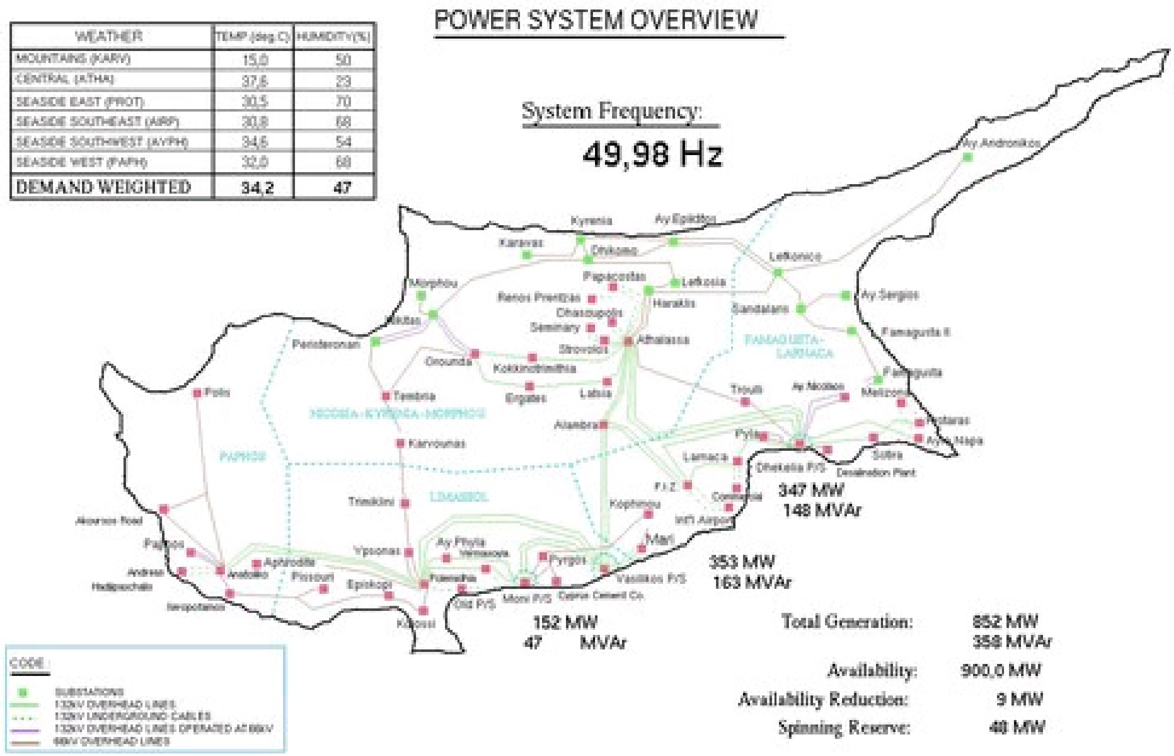
Generally, aquatic renewable resources would be used for generating electricity for the national grid. That most existing power stations are located on the coast and have access to the sea is an advantage for grid connection infrastructure for aquatic renewable resource development, as it extends the options for grid connection.

Other than electricity production, aquatic renewable energy in Cyprus may be used for desalination. Serious water shortages due to the lack of rainfall in recent years dictate the importance of desalination plants around the coast of Cyprus. Although a few plants have been deployed, the need for more plants persists. That all desalination plants are deployed by the coast makes it easier for marine renewable energy resources to be deployed in order to power the plants.

9.2.3.2. Grid network

The electricity grid network infrastructure is sufficient, and close enough to potential resource areas, to support new aquatic renewable energy projects. Most of the high voltage transmission cables and medium voltage cables are situated along the southern coastline of the island because all power stations on the island are located on the coast. That many settlements are located near to the shore makes the grid easily accessible for any renewable energy technologies installed offshore.

The only limitation to this is on the west cape where the grid may not be too easily accessible for connection of aquatic renewable energy resources. It is unlikely that a developer would be granted permission for the deployment of any kind of energy technology in this location, whether aquatic or conventional, because the area is considered a national park with strict environmental protection legislation. The map below shows the grid infrastructure in Cyprus.



9.2.3.3. Grid connections for aquatic renewables

The method for obtaining a grid connection would depend on the capacity of the power station. This option should be pursued only if the developer has already acquired the project permit from CERA.

- For power stations or other electricity generating plants with capacity less than 6 MW, the grid connection terms are issued by the Distribution System Operator (DSO), i.e. the Electricity Authority of Cyprus (EAC)
- For power stations with capacity greater than 6MW, the Transmission System Operation (TSO), an independent legal entity established by the government, will review and assess the grid connection application. The TSO will then issue the terms and conditions for grid connection, which both the power station developer and the DSO must obey. The TSO will stipulate if any infrastructural tasks will be required by either the developer, or else the DSO.

9.2.4. Industry and skills

9.2.4.1. Manufacturing capacity

There is no obvious industry in Cyprus which could provide the grounds or infrastructure for manufacturing all component devices.

It is possible that some existing construction companies in Cyprus may be able to construct and install the foundations structures for new aquatic renewable developments. Several of these companies have previously undertaken construction projects in the Middle East and have developed a reputation in this region. It is questionable, however, whether they have the real expertise required to construct foundations or other infrastructural works which may be required for the installation of aquatic renewable technologies. For run-of-river, if an appropriate resource is found, local companies could undertake the construction of any required foundation or other infrastructural works and installation of technologies.

9.2.4.2. Support facilities and vessels

Infrastructure at ports and harbours in Cyprus is adequate to support the vessels required for aquatic renewable energy projects. There are two official ports in Cyprus, and while the port of Limassol is busiest, the port at Larnaca could also be used for the operations.

9.2.4.3. Workforce

In Cyprus there are many engineers and engineering technicians, who are, or may be trained on, the development of aquatic renewable energy. Three universities offer degrees in engineering. This should support sufficient numbers of graduates who could go onto to service the areas of consulting and regulation.

Several high-level engineering technicians who graduated from The Higher Technical Institute (HTI) in Cyprus have secured high-profile jobs in a variety of public and private organisations. Although the HTI will close next year, it will be replaced by the establishment of the Technical University of Cyprus. There are many technicians in the job market from HTI who may be willing to switch to the renewable energy sector.

9.2.4.4. Educational institutes

While the only institution which has the capacity to train technicians for the renewable energy sector, the HTI, is scheduled to close in the next couple of years, it will be replaced with the new Technical University of Cyprus. It is unknown whether any other new institutions will be established to replace the technical training services currently offered by HTI.

It is possible that the three remaining universities, the University of Cyprus, Technical University of Cyprus, and private Frederik University of Cyprus, may cooperate with developers and other foreign institutions in order to provide training for personnel in the aquatic renewable energy industry.

9.2.5. Regulation

9.2.5.1. Leasing

Provided that a developer has already acquired all the relevant licences from the Cyprus Energy Regulatory Authority (CERA), followed by the Town Planning and Housing Permit and a building permit, the developer would then finalise his agreement with the land owner. In the case of sea space, the owner is the State itself, and setbacks would be limited to the agreement on leasing and rental rates dictated by the state. To lease state-owned land, the developer will have to apply to the local District Administration Office, and in the case of aquatic renewable energy, the developer must also acquire a permit from the port authority.

9.2.5.2. Consenting

Consent for aquatic renewable energy projects would require a permit from the Cyprus Energy Regulatory Authority (CERA). In granting this permit, CERA considers the opinions of stakeholders. CERA will always contact other stakeholders and government authorities to ask for their consent on projects before issuing a permit.

A developer will need a construction permit, and prior to this, must obtain a Town Planning and Housing Department Permit.

All consents are included in the one permit from CERA, thereby limiting the delay for issuing permits for deployment.

9.2.5.3. Environment

There are no additional environmental licences or permits which would be required in order to install renewable energy technologies. The Cyprus Energy Regulatory Authority (CERA) will garner the consent of all other appropriate authorities regarding environmental issues, in order to issue a permit to the developer.

9.2.5.4. Health and Safety

There are no specific health and safety issues regarding aquatic renewable energy technologies. However, the developers of aquatic renewable energy resources have to follow all the health and safety guidelines issued from the EU and national government. The conditions for granting the permits for installing the technologies are issued under these same regulations.

9.2.6. Drivers of industry

9.2.6.1. Political drivers

Cyprus is committed to the European Commission's White Paper for a Community Strategy, and its stated aim to double the share of renewable energy in gross domestic energy consumption from 6% to 12% in the EU. Cyprus is a signatory to the Kyoto Protocol, and is committed to making a contribution towards the targets set for reducing the emission of greenhouse gases.

The Cyprus Government has pledged to the European Commission that at least 6% of the domestic energy production would be utilised from renewable energy resources by 2010. Government officials have stated in the press that the only means of achieving this goal by the 2010 is through wind power, as it is the only renewable source that has secured investors in Cyprus. The Town Planning and Housing Department has prioritised all tasks involving renewable energy applications in order to expedite the issue of permits for the construction of wind farms. The priority has been towards wind farms generally, and not specifically towards offshore wind farms or other aquatic renewable energy resources.

The Cyprus Energy Regulatory Authority has issued permits for wind farms with a total capacity greater than 1.000 MW. It is not yet clear which of these wind farms will be constructed by developers.

9.2.6.2. Financial drivers

The Cyprus government established a grant scheme in 2004 for energy conservation and renewable energy sources. Aquatic renewable energy is eligible for the scheme under a specific category, NB6, which specifically refers to all renewable energy sources, excluding photovoltaics, up to 20kW small hydroelectric systems and domestic wind energy devices under 30kW. Small systems are included under other categories of the scheme and may all be subsidized. All power stations utilising renewable energy sources receive a subsidy of 6.33 c (€) / kWh. This amount is additional to the price at which the wind farm developer receives for each kWh.

Information on the scheme is provided on the website of the Cyprus Institute of Energy (CIE) at http://www.cie.org.cy.

No category in the scheme refers to a specific aquatic renewable energy technology. However, several aquatic renewable technologies such as wave energy and tidal impoundment are mentioned as examples of accepted renewable energy sources.

9.3. Greece

9.3.1. 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 [31, 32]. There are certain 'hot spots' (e.g. Crete), as a result of the complex island terrain. Recent measurements and theoretical studies [33,34] 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.

9.3.2. Development and testing

9.3.2.1. 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.

[31] Athanassoulis GA, Skarsoulis EK. Wind and wave atlas of the northeastern Mediterranean sea, GEN/OK-20/92, 1992.

[32] Pontes MT, Athanassoulis GA, Barstow S, Bertotti L, Cavaleri L, Holmes B, et al. The European Wave Energy Resource. 3rd EWEC, Patras, Greece, 1998

[33] Cavaleri L, Athanassoulis GA, Barstow S. Eurowaves: a user-friendly approach to the evaluation of nearshore wave conditions. 9th ISOPE, Brest, France, 1999.

[34] T.H. Soukissian, G.Th. Chronis and K. Nittis , POSEIDON: Operational marine monitoring system for Greek seas. Sea Technology **40** 7 (1999).

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.

9.3.2.2. 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.

9.3.2.3. 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.

9.3.3. Power use and transmission

9.3.3.1. 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.

9.3.3.2. 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.

9.3.3.3. 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).

9.3.4. Industry and skills

9.3.4.1. 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.

9.3.4.2. 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.

9.3.4.3. 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.

9.3.4.4. 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.

9.3.5. Regulation

9.3.5.1. 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".

9.3.5.2. 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.

9.3.5.3. 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).

9.3.5.4. 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.

9.3.6. Drivers of industry

9.3.6.1. 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.

9.3.6.2. 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".

9.4. Romania

9.4.1. Country resource

With only a short coastline, Romania’s primary aquatic renewable resource is hydropower. Romania has 6 TWh potential for small hydropower plants. The resources are located nationwide, except for in the Dobrogea region in the south-east of Romania.

Figures 1D1 and 1D2 illustrate the hydrographical network and key drainage basins.

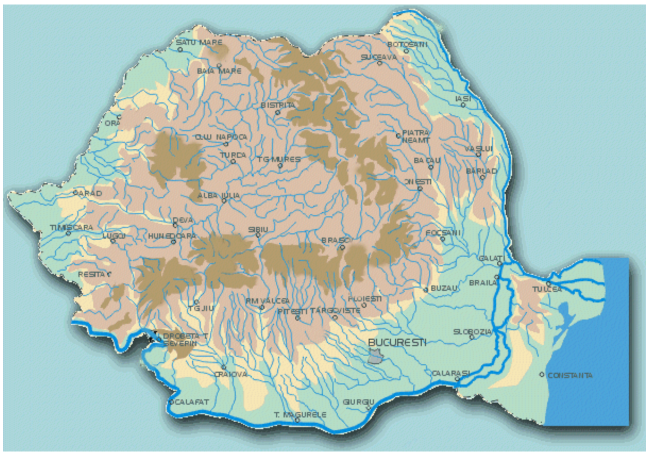


Figure 1D1. Romanian Hydrographical Network with radial distribution of rivers (SC ISPH. SA source: www.isph.ro)

Figure 1D2. Network and main drainage basins: I Tisa-Someş, II Crişuri, III Mureş, IV Timiş-Nera-Bârzava, V Cerna-Jiu, VI Olt, VII Argeş, VIII Ialomiţa, IX Siret-Prut, X Danube (SC ISPH. SA source: www.isph.ro)

9.4.2. Development and testing

9.4.2.1. Research and development institutions and facilities

There are a number of organisations and institutions in Romania with the capacity for research and development into aquatic renewables. Because of its limited coastline, Romania's primary aquatic renewable energy resource is small hydropower.

The following institutions and organisations are of relevance to R&D: the SC ICPET SA (http://www.icpet.ro/) and SC ICEMENERG SA (http://www.icemenerg.ro/) are developers with a history of renewable energy research and projects; SC ISPH SA (http://www.isph.ro/) is the Romanian Institute which has designed hydropower plants and schemes for hydroelectric development of catchments areas and has provided water courses. The Department of Hydraulic and Hydraulic Machineries at the University Politehnica of Bucharest (http://www.pub.ro/English/eng.htm), is active in this field and in 2005 formed an entrepreneurial group on SHP problems.

9.4.2.2. Technology and design testing facilities

With its short coastline, the key aquatic renewable energy resource in Romania is small hydropower. The concepts used in small hydropower generation are relatively mature, although the utilisation of these concepts in small-scale resource environments is a more recent development. The Department of Hydraulic and Hydraulic Machineries at the University Politehnica of Bucharest (http://www.pub.ro/English/eng.htm) may be able to offer information to interested parties on facilities in Romania at which hydropower devices and concepts may be tested.

9.4.2.3. Pilot zones and trial projects

There are no designated pilot zones for early-stage aquatic renewable technologies, but the Romanian Government encourages the development of renewable technologies through its national R&D program (www.ancs.ro) which includes supplementary financing projects in conjunction with European structural funds.

9.4.3. Power use and transmission

9.4.3.1. Power use options

Romania has a short coastline, so its main aquatic renewable resource is hydropower, and small hydropower in particular has growth potential. The primary use of hydropower in Romania is likely to be for electricity purposes, either through the national grid, or at the microgeneration level.

9.4.3.2. Grid network

Romania has a quality grid infrastructure to support the development of new small hydropower projects. The potential contribution of new small hydropower in Romania should be considered alongside planning for extensions to the distribution and transmission networks.

A map of the Romanian transmission grid is available here:
http://www.transelectrica.ro/harta_retea.html

Figure 2.B.1 presents information on grid facilities in Romania (www.transelectrica.ro)

	Electrical lines 110 kV	Electrical lines MT	Electrical lines JT	Transformer station 110/MT si MT/MT		Transformer posts and supply points	
Branch	km	Km	km	nr	MVA	nr	MVA
MOLDOVA	2685,32	17110,96	31113,23	134	4178,6	10113	2907,84
DOBROGEA	2169,61	11313,7	10743,61	295	5338,37	5727	2515,91
MUNTENIA NORD	2160,672	15374,107	21765,12	208	5419,15	9157	3031,32
OLTENIA	3536,754	19827,084	27142,18	236	7016,2	9923	3160
BANAT	2014,72	13513,702	18419,02	140	4855,1	6690	2082,992
TRANSILVANIA NORD	2140,192	16687,333	22383,29	114	3916,14	6182	2118,053
TRANSILVANIA SUD	2257,29	12883,75	19256,38	109	4095,8	7142	2359,2
MUNTENIA SUD	784,903	13311,716	21532,08	60	3667,2	5676	2976,976
Total SC ELECTRICA SA	17749,461	120022,352	172354,91	1296	38486,56	60610	21152,291

9.4.3.3. Grid connections for aquatic renewables

It is not difficult to obtain a grid connection for a small hydropower project in Romania if there is a nearby grid with distributed generation capability. Costs for connection to the grid are separated into those for power transportation and those for auxiliary services (e.g. reserve and balance). Before connecting, generators should estimate capital costs and other associated project costs, in order to reduce or limit constraint levels on the network.

The integration of aquatic renewable projects into the grid will alleviate difficulties related to localisation of plants, and will also allow the management of aquatic renewable energy production in a market context. However, despite widespread grid coverage in Romania, and the benefits of incorporating small hydropower projects onto the grid, there are regulatory and institutional difficulties for aquatic renewables projects in connecting to the grid. Solutions to grid connection difficulties should be considered within new renewable electricity regulations and proposals in Romania. Solutions should consider new technical interconnection standards.

In order to generate aquatic renewable electricity in Romania, the following licenses are necessary:

- Legal documents issued by the network operator to which the generator will be connected (e.g. location approval; technical condition approval). More detail on the requirements necessary to obtain these permits is available in a guide (http://www.anre.ro/documente.php?id=394) produced by the Romanian Energy Regulatory Authority (ANRE) for renewable electricity generators.

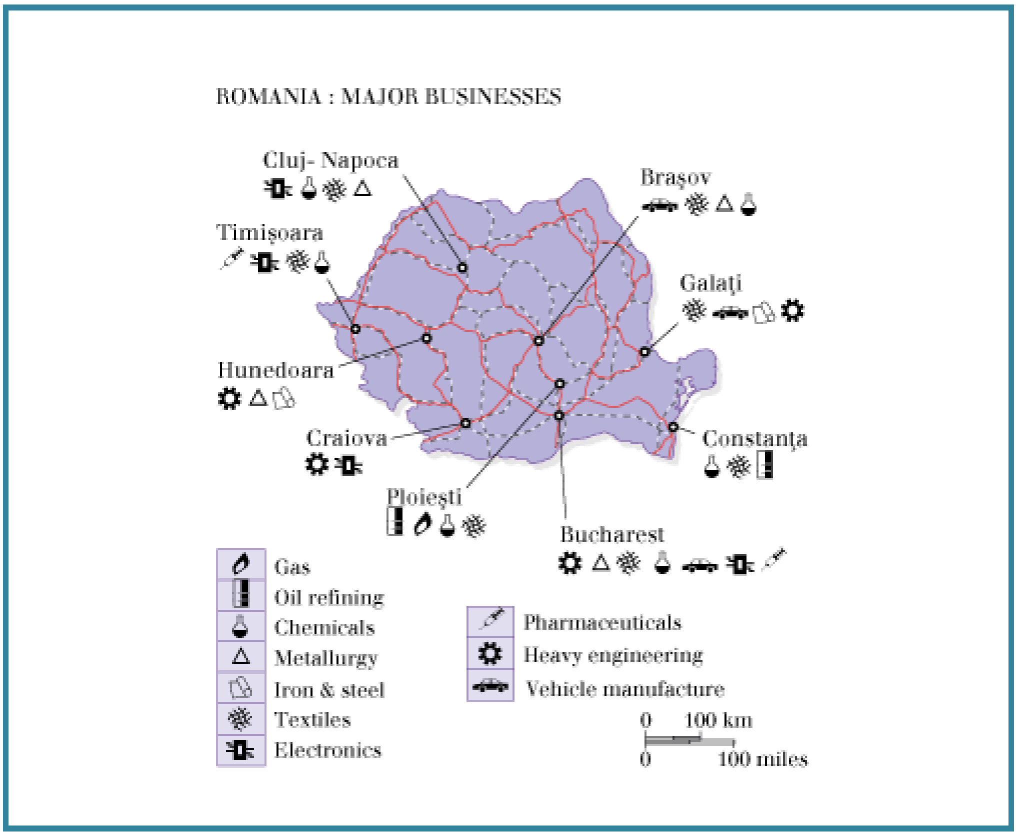
The Romanian Transmission and System Operator (TSO) is Transelectrica (http://www.transelectrica.ro). Projects wishing to connect to the Romanian transmission grid should contact Transelectrica. Projects wishing to connect to the Romanian distribution networks should also contact Transelectrica because certain approvals from Transelectrica are also required for distribution-linked projects. The "Services" page of the Transelectrica website outlines the process for connection to the Romanian transmission grid (http://www.transelectrica.ro/2en.php).

9.4.4. Industry and skills

9.4.4.1. Manufacturing capacity

The key aquatic renewable resource in Romania is hydropower, due to the country's short coastline. In order to further the development of the hydropower industry in Romania, skilled workers and technology from the existing manufacturing and construction base may be useful. In 2006, manufacturing accounted for 25.5% of Romanian GDP, and was growing at an annual average rate of 6%. Traditionally, the manufacturing sector in Romania has focused on machine tools and automobiles. Approximately two thirds of the Romanian workforce is employed by small- to medium-sized manufacturing firms. These individuals may be able to contribute to the hydropower sector in the future.

The Figure below demonstrates the location of different industries within Romania, including heavy engineering, iron and steel, and automobile manufacturing.



9.4.4.2. Support facilities and vessels

Romania's key aquatic renewable energy resource is hydropower. Infrastructure for the deployment and development of other aquatic renewable sources such as tidal stream, tidal barrage, wave and offshore wind, is not of relevance. Romania has sufficient capacity and a quality transport infrastructure for the development of hydropower projects.

9.4.4.3. Workforce

The expansion of aquatic renewable energy will stimulate the economy of local communities. Using renewable energy technologies creates employment at higher rates as compared to other energy technologies. This has been shown through the growth of the state-owned hydropower company Hidroelectrica. There is an indigenous workforce employed at Hidroelectrica which may be available to support the development of aquatic renewable energy projects. This includes employees involved in maintenance, operation, and construction. An outline of the services provided by Hidroelectrica is available on their website: http://www.hidroelectrica.ro.

The engineering capacity of Romania is well illustrated by the Society of Power Engineers in Romania (www.sier.ro).

9.4.4.4. Educational institutes

There are a number of institutes in Romania which have expertise in hydropower and could be approached for training purposes.

The SC ICPET SA and SC ICEMENERG SA are developers with a history of renewable energy research projects. SC ISPH SA is a Romanian institute with a proven history in the design of hydropower plants, a facilitator of schemes for hydroelectric development of catchments areas, and training provider of water courses. The Department of Hydraulic and Hydraulic Machineries at the University Politehnica of Bucharest is active in the hydropower field, and in 2005, formed an entrepreneurial group on SHP challenges.

9.4.5. Regulation

9.4.5.1. Leasing

A developer must purchase or lease the river from the owner of the land. The owner of river land space could be a physical person, the local community, the town hall or local department of forest administration. Sea space could be leased from the Romanian Waters Agency (www.rowater.ro).

Hidroelectrica (www.hidroelectrica.ro) and the Romanian Waters Agency are public organisations which provide advice to developers of hydropower plants, and could specify land owners and indicate lands available for purchase or lease.

9.4.5.2. Consenting

The Romanian Energy Regulation Authority (ANRE) indicates on their website (http://www.anre.ro) the steps a developer should take to install a renewable energy project and become a renewable electricity producer that contributes to the electricity market.

In order to develop an aquatic renewable energy project, there are a number of consents required for building and establishing the project. These would be additional to the purchase of land, licence for connection to the grid, and other environmental considerations. These include:

- Legal documents issued by the local administration authorities (e.g. city planning certificate; building authorisation)
- Legal documents issued by ANRE (e.g. setting-up authorisation for power units with capacity greater than 1MW; an E-RES generation licence; qualification certificate for the electricity priority production)

A guide for renewable electricity producers on the ANRE website (http://www.anre.ro/documente.php?id=394) outlines more detail on these licences.

It may take between five and seven months to obtain the required number of licences for a renewable electricity project, which may prove to adversely affect the developer.

9.4.5.3. Environment

It is best practice to consider environmental impacts when developing an aquatic renewable energy project.

There are several Ministries of the Romanian government from which advice may be sought on environmental compliance:

- Ministry of Environment and Sustainable Development (http://www.mmediu.ro/index_en.html)
- Ministry of Agriculture and Rural Development (http://www.madr.ro/)
- Ministry of Development, Public Works and Housing (http://www.mdlpl.ro/)

9.4.5.4. Health and Safety

In terms of health and safety, developers of aquatic renewable energy projects in Romania should be aware of, and comply with, the ANRE (Romanian Energy Regulatory Authority – www.anre.ro) maintenance regulations. Developers should contract for technical assistance with Hidroelectrica (www.hidroelectrica.ro), the state-owned hydropower company.

9.4.6. Drivers of industry

9.4.6.1. Political drivers

There is political support for renewable energy production in Romania, which was one of the first EU candidate countries to transpose the provisions of Directive 2001/77/EC, on the promotion of renewable electricity, into its own legislation (i.e. GD no. 443/2003 with modification of GD no.958 / 2005). Its indicative target for renewable electricity production by 2010 is fixed at 33% of gross national electricity consumption.

Currently, depending on the hydrological factors, 25 – 30% of green electricity in Romania is from hydro sources. Approximately 96% is generated in large hydro power plants and 4% in small hydro power plants. Only 1% of total electricity production in Romania comes from wind generation.

Though political support does exist, stronger regulation is needed to overcome barriers preventing targets from being met. In order to stimulate widespread generation from small-hydropower in Romania, new regulations could be implemented to address technical interconnection standards, and mitigate regulatory and institutional barriers to generation. Any new regulation should consider challenges to the development of aquatic renewable projects in Romania, including services for producers, validation of produced energy, and grid connection issues.

9.4.6.2. Financial drivers

There is strong financial support for aquatic renewable energy deployment in Romania. The main source is through the generic renewables support scheme, which consists of a mandatory quota system and trade system, with minimum and maximum price limits for the green certificates (GC) produced.

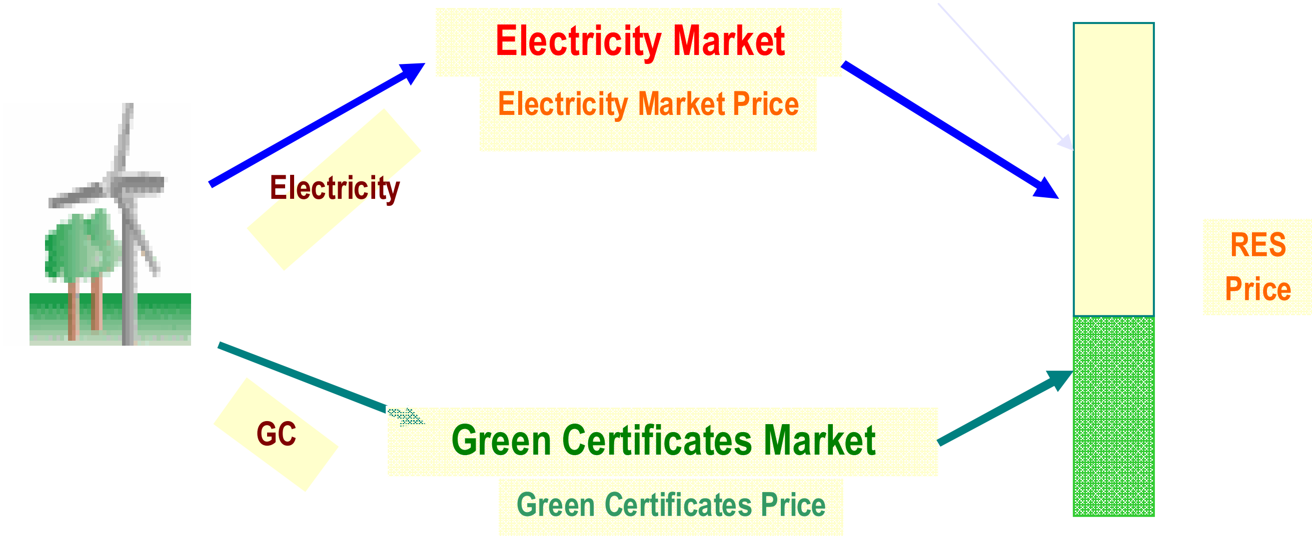
Each year, electricity suppliers are obliged to comply with mandatory quotas for renewable electricity supply. These quotas are established through legislation for each year between 2005 and 2012.

A renewable electricity generator may sell electricity on the electricity market, like any other electricity producer, obtaining the market price. In order to fund the higher generation costs for renewable electricity, and to ensure a reasonable profit, the generator receives a GC for each MWh of electricity supplied in the electricity network. This GC may be sold to electricity suppliers within legally set price limits, and are currently at a minimum of 24€ per certificate, and a maximum of 42€ per certificate. The renewable electricity generator may sell their electricity through a bilateral contact or on the day-ahead market (DAM).

Electricity suppliers demonstrate compliance with the quota system by the number of GCs they buy each year. This number must equal the mandatory quota value multiplied by supplied electricity quantity.

If suppliers do not comply with the annual mandatory quota, they will pay to the TSO (CN TRANSELECTRICA SA, www.transelectrica.ro) a fee related to the value of the GCs they were unable to buy. From 1st January 2008, this fee has been set at a value representing double the maximum trade value of GCs.

The following diagram illustrates this mechanism:



9.5. Portugal

9.5.1. Country resource

Offshore wind

Although the potential for offshore wind is not as significant in Portuguese waters as compared with other northern European coastlines, calculated values indicate annual average speeds of 7-8 m/s off the Portuguese coast.

Wave

The west coast of Portugal presents good conditions for large-scale wave energy implementation, with the resource generally decreasing from north to south (35-40kW/m north to 25kW/m southwest). Overall, the best conditions are found in the northern part of continental Portugal and the Autonomous Regions, taking into account of the type of sea bed, conflicts of use, and the resource.

Tidal stream

Only the estuaries of the larger rivers (e.g. Douro, Tejo, Sado, Guadiana, Lima) and some specific locations at the coastline may be of relevance. At the present stage of technology development, average flow levels are not generally considered attractive for commercial exploration.

Run-of-River

Due to the high level of hydropower implementation and the seasonal and annual variation of rainfall and flow levels in Portugal, development of the run-of-river sector is generally not considered a major option at this stage.

Tidal Range

Once technology for this sector has advanced, tidal impoundment could possibly be an option for the coastline, due to the relatively moderate tidal variations (1.5 – 3.5m peak level differences).

9.5.2. Development and testing

9.5.2.1. Research and development institutions and facilities

Research and development (R&D) into aquatic renewable energy in Portugal has been rather limited to theoretical or small-scale model testing.

A number of Portuguese universities – namely, the IST (Instituto Superior Técnico), FEUP (Engineering Faculty of Porto University) and Aveiro University - have been involved in a wide range of R&D activities for aquatic renewable energy.

Some research, for example, on the wave energy resource and hydrodynamics, has been carried out by the INETI (National Institute of Innovation and Technology). However, the INETI has now closed, and has been replaced by the new National Laboratory for Energy and Geology (LNEG).

The non-profit association Wave Energy Centre (WavEC) is involved in wave energy R&D activities in fields where there is a lack of knowledge, or where this is desired by its associates.

Of the larger companies, only Martifer runs its own R&D in wave energy. Efacec undertakes R&D and innovation work on electronic components. In terms of small-to-medium enterprises, Kymaner, founded in particular for wave energy technology development, puts research efforts into mechanical issues.

9.5.2.2. Technology and design testing facilities

In terms of Portuguese facilities for testing of aquatic renewable energy technology, the test installations available are mainly suitable for small-scale laboratory (hydrodynamic) tests, with installations available at IST (Instituto Superior Técnico), LNEC (National Civil Engineering Laboratory) and FEUP (Engineering Faculty of Porto University).

Electronic components can be tested in the respective University laboratories or some installations of commercial entities.

The OWC (oscillating water column) wave energy pilot plant on the Island of Pico/Azores, is currently being proposed by WavEC as a real-scale test bed for air turbines. A wave energy pilot zone is being planned for testing and demonstrating wav energy devices under special conditions.

9.5.2.3. Pilot zones and trial projects

There is no significant potential for tidal stream, range or run-of-river in Portugal. There have been no initiatives for these technologies.

Despite the presence of the resource, offshore wind energy has not been considered for Portugal due to the steep continental shelf, which would make project design more difficult, and also mean projects must be closer to the shoreline. Offshore wind has only recently started to be recognised due to advances in floating platforms, which will allow development in deep water. The Government has not set up any pilot zones for the encouragement of offshore wind around Portugal.

Development of wave energy around Portugal has been seriously considered. In early 2007, a wave energy pilot zone of 320 km2 was adopted in a proposal of a decree-law, effective in April 2008 (Decree-Law nº5/2008). These zones would be for an installed potential of 80 MW in a first phase, and 250 MW in a second phase. The zone can be seen as highly innovative for Portugal, because of its large size and the fact that the concept was adopted in 2005, early in the development of the wave energy sector both in Portugal and globally. This reflects the strong expectations of wave energy development in Portugal. The time taken for the implementation of the pilot zone is worrying, as between 2005 and now, there has been limited, if any, progress. This will be a critical aspect for this undertaking, and whether wave energy devices can actually be tested by 2010.

9.5.3. Power use and transmission

9.5.3.1. Power use options

Portugal faces a significant deficit of electricity production and security of supply, particularly during "dry" years with limited rainfall, due to its large dependence on hydropower. Electricity production to the national (or regional) grid is therefore of high priority for aquatic renewable energy; however, their limited suitability for base load production certainly makes storage a potentially important component.

As run-of-river potential naturally coincides with hydropower potential, it could be used to expand the pump storage capacity of hydropower dams.

Microgeneration from aquatic renewable energy is likely to play a minor role in remote areas with characteristically isolated communities where grid connection is weak at best. On the Islands (e.g. Azores & Madeira archipelagos), microgeneration is likely to be feasible in some niche areas due to the large wave energy potential and insufficient grid infrastructure.

Heat energy and electricity are unlikely applications for aquatic renewable energy in Portugal, although wave energy could potentially contribute to heating needs in some areas during the winter months.

9.5.3.2. Grid network

The Portuguese electrical grid is strongly orientated in a north to south direction, with its backbone close to the coastline. Wave energy, and potentially offshore wind energy, is thereby appropriate for Portugal. Even with large-scale implementation of aquatic renewable energy, the challenges to the existing grid could be controlled. As with onshore wind energy, for instance, a weak grid in areas with resource availability has been a major obstacle to implementation.

Only a limited number of run-of-river projects are viable for Portugal. These small and micro installations of run-of-river will not pose a problem to the grid.

In Portugal, the implementation of new aquatic renewable energy will most likely concentrate on the coastal area, in particular in the northern areas of the country.

9.5.3.3. Grid connections for aquatic renewables

A grid connection for an aquatic renewable energy project in Portugal is requested via a "PIP" (Pedido de Informação Prévia – Request of Previous Information). Obtaining this connection can be difficult. The organisation responsible the connection process is DGEG (General Directorate for Energy and Geology[35]). An environmental impact statement, deployment and operational licenses are also required, which are further described in Sections II and III in Part 5.

[35] www.dgge.pt

9.5.4. Industry and skills

9.5.4.1. Manufacturing capacity

Despite the limited industrial capacity of Portugal in general, there is potential production capacity for aquatic renewable energy. One reason for this is that the country has significant experience with medium and large-scale hydropower, including all adjacent work phases. This experience will be relevant for run-of-river, but also for other aquatic renewable energy technologies.

Mainly in the north Porto area of Aveiro, but also in the Greater Lisbon area, there are industrial capacities for device and support structure manufacture. There are a number of cable manufacturers with proven capacities, as well as strong coastal engineering contractors and substation suppliers. Several shipyards with significant capacity for the assembly and preparation of devices for deployment and maintenance are also available.

The size of aquatic renewable plants and their modular set-up will help to build new manufacturing capabilities in Portugal. This is a national priority, and is often pursued by regional and local authorities. Peniche township (i.e. southern-central Portugal) for instance, has reserved large areas for potential wave energy manufactures.

9.5.4.2. Support facilities and vessels

The transport and harbour/port infrastructure will be sufficient to support the take-up of the industry. Expansion or adjustments to the layout of some harbour areas will be required once large-scale implementation takes place. Several areas have the potential for such a development, which is why transport and harbour infrastructure will not inhibit the growth of aquatic renewable energy sectors in Portugal.

Vessel availability for aquatic renewable energy deployment and maintenance may be limited with only tug boats and other generic vessels available, as opposed to specialised working vessels. This may potentially be a limiting factor, much more so than harbour/transport infrastructure availability, in the early stages of the aquatic renewable energy sectors in Portugal. The deployment of the Pelamis machines off the coast of Póvoa de Varzim in 2008 demonstrated the potential difficulties due to the absence of specialised and sufficiently sized working vessels. Similarly, a working vessel had to be rented from the Netherlands for the AWS pilot plant tests in 2004.

There is strong will and potential in Portugal to grow a domestic aquatic renewable energy industry. This is for energy purposes but also in order to support the rather weak employment market and industrial structure. However, due to a lack of experience and rather moderate financial options, some of the structural weaknesses may take longer to overcome than intended.

9.5.4.3. Workforce

The availability of sufficiently trained people to support the development of aquatic renewable energy projects in Portugal is not critical in the initial phase, as all required skills are available in related industrial branches, and unemployment levels are high and increasing.

Some human resource requirements may be in short supply when commercial scale deployment takes place. On the other hand, several relevant specialists, such as construction, manufacturing and engineering consultants, have suffered from recession, which would lead to benefit a growth in the aquatic renewable energy sector, and in particular, the wave energy market segment. There will be time for human resources to grow together with the sector, at a similar pace to the extra required infrastructure.

9.5.4.4. Educational institutes

There are several major Universities in Portugal which could provide a reasonable quantity and quality of relevant technical education for workers in the aquatic renewable energy industry. With respect to non-academic degrees, some structural weaknesses in the educational system have meant that technical professions cannot easily be learned other than through work experience. The concept of practically-oriented professional schools has traditionally not been pursued in Portugal.

Engineering degrees can be obtained in the major technical schools such as IST (Instituto Superior Técnico), FEUP (Engineering Faculty of Porto University), Aveiro University, Coimbra University, and New University of Lisbon, as well as polytechnic institutes countrywide.

Some of these schools have dedicated renewable energy master modules, and in some cases focus on aquatic renewable energy, as part of engineering degrees.

9.5.5. Regulation

9.5.5.1. Leasing

The concept of purchasing or leasing sea-use is not common in Portuguese legislation. For aquatic renewable energy projects, only run-of-river has been traditionally subject to this situation. When sections of rivers are part of private space, their use has to be licensed in the context of land-use planning, requiring an exploration license for the aquatic resource.

Traditionally, the sea was not used for energy generation. Substantial changes are expected in the context of the national application of the water framework law; however, this may not necessarily involve land and sea lease or purchase.

9.5.5.2. Consenting

Developers of aquatic renewable energy projects require four licenses in order to pursue development:

- License of water use
- License for construction (prior environmental consent required)
- License for establishment
- License for exploitation

Whereas the first two licenses have to be obtained from the regulatory body for water (INAG – the Water Institute[36]), the latter are granted by the Directorate General for Energy and Geology (DGEG[37]). A grid connection point must be requested from this same body ("PIP" – Pedido de Informação Prévia)

9.5.5.3. Environment

For any project involving construction in a body of water, environmental consent is required. No specific rules have been documented to date for most aquatic renewable energy projects. Small hydropower (i.e. the regime under which run of river plants would fall), an environmental incidence study is required. For larger projects (e.g. coastal structures), a more comprehensive environmental impact study is needed.

The Wave Energy Centre (WavEC) has been working on environmental issues and generating conclusions for consent issues, with respect to wave energy, and in terms of large-scale deployments and the wave energy pilot zone (see Part 2, Section III).

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[36] www.inag.pt

[37] www.dgge.pt

Challenging, but not insurmountable, issues for the licensing of aquatic renewable energy are naturally Rede Natura 2000 sites, as well as sites under special national protection regime (REN – Reserva Ecológica Nacional). Whereas Rede Natura 2000 covers wide areas of the coastline in mostly shallow waters, and do not pose a major obstacle to some aquatic renewable energy projects, REN can impose more specific and less flexible restrictions.

A critical player in the context of environmental licenses is the newly created environmental agency, APA – Agência Portuguesa do Ambiente[38]

9.5.5.4. Health and Safety

There is no specific health and safety regulation related to aquatic renewable energy. Due to the lack of offshore oil and gas industry, the maritime sector has not yet been subject of specific health and safety rules. For construction activities, and in the context of operation or maintenance, the specific regulations for construction yards and maritime activities have to be taken into account, as well as several European Directives transposed into national law.

The most relevant health and safety decree-laws include:

- DL 441/91: establishes the legal regime for safety, hygiene and health at work;
- DL 280/93: establishes legal regime for harbour works;
- DL 347/93: minimum safety and health prescriptions at work; transposition of EC Directive 89/654/CEE;
- DL 12/94: approves regulations for professional diving;
- DL 26/94: organisation and functioning of health and safety activities at work;
- DL 100/97: work accidents and professional sicknesses;
- DL 273/2003: revision of the regulation of safety and health conditions for work in temporary or movable construction yards as set out in DL 155/95; incorporating minimum prescriptions according to EC Directive 92/57/CEE.

[38] http://www.apambiente.pt/Paginas/default.aspx

9.5.6. Drivers of industry

9.5.6.1. Political drivers

There has been substantial political will for the development of renewable technologies in Portugal. Since 2000, the opportunity for renewable energy implementation on a large-scale has been recognised by the government, in particular with respect to marine renewable energy.

There are a number of legislative documents demonstrating the will to reduce Portugal's dependence of fossil fuels and reduce pollution. The first legal documents date back to 1988 which established rules for independent producers. Since 1999, and in particular from 2001 onwards, when clear feed-in tariffs for renewable energy were established, the baseline for strong renewable energy implementation was recognised by government officials.

In early 2007, the creation of a wave energy pilot and demonstration zone, with facilitated access and a subsidised tariff, was announced. This was established by law in February 2008 (see section III of Part 2), re-introducing the tariff of approximately 25cEUR/kWh. This represents the level of expectations in Portugal for energy conversion from ocean waves.

Other aquatic resources are less important from a national strategic viewpoint, due to a high grade of saturation (e.g. hydro power), limited resource (e.g. tidal energy & river flow), or non-favourable geographic parameters (e.g. offshore wind). Most of the information is biased towards wave energy, which is seen as the most promising source, along with onshore wind energy, where there has been a substantial increase of installed potential since removal of legal barriers in 2004-2005, and solar energy, where there are several multi-MW projects being built or planned.

Surveys carried out by WavEC since 2004 indicate that there is wide public support for wave energy implementation, if proper information and dissemination measures are taken beforehand.

9.5.6.2. Financial drivers

In general, Portugal offers the two most common support mechanisms, simultaneously: revenue support via established feed-in tariffs, and grant support for demonstration projects, and to a smaller extent, for established aquatic renewable plants. Fully or partially refundable credits and tax credits are also part of the financial support mechanisms in Portugal.

The feed-in tariff is defined by law within certain limits. For example, for small hydropower the tariff is slightly above 7cEUR/kWh, and for wave energy it is approximately 25cEUR/kWh initially, decreasing towards 16-18cEUR/kWh in a pre-commercial phase and finally yielding < 10cEUR/kWh in a commercial phase. Tidal energy and offshore wind have not yet been considered in the legislation. The feed-in tariff is guaranteed and may be negotiable in some cases, once that the grid connection is granted (DGEG[39]).

Capital grants and other mechanisms are typically administered by ADI (Innovation Agency[40]), in the context of the Ministry for Economy.

The private finance market has started to invest in aquatic renewable energy, mainly in wave energy projects or individual developers. To date this has mostly involved project developers of similar technologies and mainly wind technologies, whereas investment from venture capital funds and pure finance companies is in the initial phase.

[39] www.dgge.pt

[40] www.adi.pt