

AquaRET Learning Materials - The Educational Potential

1. Introduction

Renewable energy, and in particular aquatic renewable energy, is a rapidly evolving sector. This is, however, no ordinary industry. Renewable energy technologies represent an important part of the solution to global warming, itself arguably the greatest challenge that has ever faced humanity. Renewable energy technologies also offer economic possibilities. The credit-crunch and what now looks like recession may present the opportunity for the transformation of our energy systems and the emergence of carbon-free economies powered by renewable energy technologies.

It is fair to say that there is an increasing general awareness of the need for renewable energy. However levels of technology-specific knowledge among the public at large, the media and even some key decision makers is remarkably low. It is still common to find headline articles in national newspapers confusing wave and tidal technologies and making fundamental errors in the reporting of basic facts and scientific principles. Politicians give verbal support to the sector but many of them lack even rudimentary knowledge of the state of technological development, the timescales involved and the levels investment required.

Aquatic renewable energy technologies offer tremendous economic opportunity. However the development of these technologies is not simple, with many important technical hurdles still to be overcome. Like all other industrial activities there will be impacts associated with development. Once fully commercialised the industry will occupy substantial sea areas and may displace traditional sea users. Marine renewable energy has the potential to help address climate change but it may itself have unanticipated impacts on the environment.

If these opportunities are to be realised, and these challenges are to be resolved, decisions need to be made. Choices need to be taken with respect to which technologies to develop, how they will be financed, where they will be located, as well as how they will be installed and maintained. These are significant decisions that require public debate and this debate needs to be made from an informed position.

The aim of Aqua-RET is to help start the process of educating the public at large, marine stakeholders, and the media and decision makers about aquatic and marine renewable energy. Aqua-RET intended to provide objective, up to date and freely available educational material about aquatic renewable technologies. The material is targeted at a range of audiences and delivered in variety of formats.

This short report will examine some of the educational possibilities offered by Aqua-RET. Anticipating some of the possible uses of Aqua-RET material will help the project team target potential users. It is worth noting however that the free web access to Aqua-RET will result in unforeseen and unanticipated uses of this material.

2. Primary Education

Primary education across Europe has undergone a transformation in recent decades. The development of core skills (e.g. numeracy, literacy) is still the principle function of the primary education sector. However children are now also encouraged to develop key learning and social skills (e.g. information retrieval and processing; group work). An important change has been the increased contextualisation of the learning process. Core skills are increasingly taught within a context, making use of case studies and examples in order to highlight their relevance and maintain learner interest.

Another change in the curriculum, notably in the UK, is the inclusion of environmental studies. While environmental issues are necessarily taught at a rudimentary level there is an effort to approach even basic environmental science from a systems perspective. The interrelationships between parts of the ecosystem, human activity and the environment are emphasised. Exploitation of fossil fuels and global warming are an obvious example of this approach. Renewable energy alternatives to fossil fuels, and consequently Aqua-RET, are clearly relevant in this context.

The Aqua-RET web text is delivered in three levels of increasing complexity. Even level 1 content is probably too sophisticated to be directly used as learning material for primary age children. The material will however provide a resource for primary school teachers developing class material.

Key uses

- Resource for teachers preparing class material particularly in the context of environmental studies.

3. Secondary Education

There are no common European standards for either curriculum content or delivery in secondary education. There are significantly different approaches to curriculum content delivery and assessment across Europe. However some generalisations are possible. Secondary education across Europe is typified by the processes of subject differentiation and streaming. Compared to primary education the curriculum is more clearly divided into academic disciplines. Teaching is delivered and assessed in discrete units. As students advance through secondary years they generally specialize in an increasingly smaller number of disciplines. The extent of these processes varies from country to country. Scotland and France for example have secondary education systems which allow a high

level of subject choice compared to the English system, which emphasises greater depth of knowledge over a smaller range of subjects.

Aqua-RET material will have various applications in the context of secondary education; these include:

Key Uses

- **Physics and engineering:** these subjects at secondary school develop basic Newtonian physics. The principles of gravity, power, work and momentum can all be taught in the context of aquatic renewables. The basic principles of energy and the laws of thermodynamics can also be illustrated using renewable energy examples. Forms of energy (i.e. mechanical, electrical, potential and kinetic), energy transformation and storage are fundamentals of engineering and key to understanding aquatic renewables. Electricity and the relationship between the rated power of a device or machine and actual electricity generation and use can be easily illustrated. More advanced studies will examine waves, their constituent parts (e.g. wavelength, period, frequency) and interaction (e.g. refraction, attenuation).
- **Geography and environmental studies:** these disciplines develop students' understanding of basic environmental processes and human interactions with the environment (i.e. resource exploitation, pollution and ecosystem services). Basic environmental processes (e.g. water cycle, waves and tides) are discussed within the Aqua-RET materials. The distribution of aquatic energy resources is described in Aqua-RET and the link between these resources and basic earth processes (e.g. tides prevailing winds) is easily made. The complex pressure/state/response relationships – between fossil fuels (environmental pressure) global warming (state – spatially and temporally diffuse) and renewable energy (response - with its localised impacts) – is perfectly illustrated in Aqua-RET. There is further potential to explore planning issues and key characteristics of conventional power generating technologies which use concentrated (and transportable) fuels compared to renewable energies which rely on a diffuse energy flux and which are geographically constrained (i.e. the technology must be located where the energy flux exists in the environment).
- **Language:** Aqua-RET material could be used to develop language skills. Students could be challenged to prepare interpretive material (e.g. a newspaper article) which summarises Aqua-RET material. The material provides a balanced view of the state of the technology and potential environmental impacts. This makes it ideal source material for debates and topical studies.
- **Foreign language:** It is possible that Aqua-RET material could be used for more advanced foreign languages teaching.

4. Tertiary Education

Tertiary (post school) education covers a wide range of subjects taught at a variety of levels. Further education colleges deliver vocational training while universities delivery more academically orientated courses at undergraduate and postgraduate levels. The possibilities for Aqua-RET material are as varied as the courses themselves.

One increasingly common feature of tertiary provision is the use of distance and blended learning material. This frequently involves the use of web based learning materials often using proprietary e-learning environments such as WebCT or Blackboard. These tools are used by on-campus students as well as distance learners.

A common failing of online delivery is simply to use e-learning environments as a repository for conventional text based notes. This fails to exploit the full learning potential of these new media. Animation is one of the interesting possibilities presented by online learning however good animation and high quality diagrams are time consuming and expensive to create. The Aqua-RET animation will be quickly adopted by tutors developing e-learning material. Because Aqua-RET material is web based it will be easy to direct students to it using hypertext links.

Key Uses

- Physics and engineering: the uses of Aqua-RET material may be less than expected in this context, when compared to secondary education. In terms of core competencies, physics and engineering students on specialist degree courses will quickly go beyond the level explained in the Aqua-RET material. However the material will be useful for putting core knowledge in context.
- Environmental studies, planning: Aqua-RET material has potential to become an important resource for students on environmental studies courses and their tutors. Complex relationships between fossil fuels and climate a change on one hand and renewable energy and stakeholder conflicts can be explored in depth with the aid of Aqua-RET. Planning conflicts and compromises can be illustrated with this material (e.g. conflicts between national renewable energy targets, regional policy and EU conservation objectives). Students of marine planning can examine the impact of closed areas on marine users and consider the legal implications of this development (e.g. navigation, fisheries, Marpol, Osparcom).
- Students studying applied aspects of environmental studies, in particular environmental risk assessment (ERA), environmental impact assessment (EIA) and strategic environmental assessment (SEA), will be able to draw on Aqua-RET material. The Environmental Interaction Matrices that have been produced are good exemplars of the Leopold matrices routinely used as the basis of commercial EIA studies. Students could easily take these and develop impact scales and complete a rudimentary EIA.

- Energy studies: Obviously Aqua-RET material is highly relevant to modules and courses in energy studies. In Aqua-RET students have a single source which gives and accurate and balanced overview of five technologies providing a building block for further investigation.
- Economics, environmental economics, politics, and economic geography: the distribution of energy resources is a key determinant of geopolitical and economic power. Conventional energy resources and their distribution are key to understanding the economics and politics of the 20th century. As peak oil is passed and tackling climate change becomes an imperative, the distribution of renewable energy resources will shape economic the economic and political landscape as we advance through the 21st century. Renewable energy also provides a useful vehicle to explore issues such as externalities, public goods and the role of economic instruments (taxes tradable permits etc). The role of state versus state-supported private sector in the delivery of renewable energy, and energy in general, is an important debate for students of politics and economics.
- Modern languages: Aqua-RET could provide a useful source of technical material at different levels of difficulty for interpretation.

5. Continuing Professional Development

Continuing Professional Development (CPD) is training targeted at individuals in the workplace. CPD is generally intended to ensure that knowledge and skills are kept up to date. Initially CPD requirements were introduced by professional associations in order to ensure that affiliates stayed abreast of technological and legal developments in their specific professional fields. Many professional associations (e.g. RICS, RIBA) compel their members to undertake a minimum number of hours of CPD each year. The principle of CPD has spread and most companies now recognise that CPD is important not only for maintaining the competence of staff but also maintaining staff motivation. Increasingly employees expect and value training. Indeed the notion of CPD has extended to the level of individuals. In competitive labour markets many individuals voluntarily seek opportunities for CPD in order to enhance their employment and prospects.

CPD training materials are characterised by a number of features:

- It should be deliverable in discrete self-contained packages.
- It may need to be accessible to individuals from a variety of backgrounds.
- It may be useful to have the material available at different levels.
- The ability to be delivered flexibly either in the work place or at the convenience of the employee is advantageous.
- Material which is provided by recognised authorities or somehow accredited may be required.

- The ability to test trainees and verify competency is desirable in some situations.

Aqua-RET material either meets or has the potential to satisfy these objectives.

Key Users

- Aqua-RET material lends itself to CPD applications. The material would be relevant to members of a wide range of professional associations, particularly in the fields of mechanical engineering, electrical engineering, civil engineering, surveying, architecture, public administration etc.
- There may be an interest for Aqua-RET amongst employers. These may include the utilities, local government, regulators and large environmental and engineering consultancies.
- There is a market for CPD targeted at individuals and doubtless individuals will look at Aqua-RET material for their own interest and self improvement. However certification is often an important motivator for individuals. Third party testing and certification is an important future development that may be considered for Aqua-RET. Free access to the Aqua-RET material could still be maintained. Maintaining an assessment procedure would however incur a cost and therefore a charge would need to be levied if individuals wished to be assessed. The European Computer Driving Licence (ECDL) is good example of CPD together with third party testing and certification.

6. Aqua-RET as briefing material

The introduction to this short report noted the poor level of knowledge, about aquatic renewables, displayed by many decision makers and media commentators. The accurate reporting of fundamental principles and clear facts is essential if the quality of public debate is to be raised and good decision making facilitated.

It is clear that the full scale commercial development of aquatic renewable energy will require compromises and difficult decisions. Full scale wave energy may close large sea areas from other sea users, tidal barrages will have environmental impacts and tidal current development may impact on navigation routes. Society needs to decide how to deal with these impacts. This difficult process is made immeasurably harder when the public debate is polluted by inaccurate information.

Untruths and rumours already abound, including:

- false information - e.g. “it takes more energy to construct a wind turbine than it ever generates”
- sweeping statements - e.g. “tidal energy has no environmental impacts”
- technical inaccuracies - e.g. “... the windmill will generate 3MW of electricity”

Aqua-RET has the potential to become a trusted source of accurate and unbiased information. It could become a reference for politicians and their advisors, media commentators and researchers, so that they can access information about aquatic renewable energy and technologies.

Potential users

- Politicians and their researchers
- Regulators
- The media
- NGO's
- Stakeholder groups
- Professional associations
- Think-tanks, and lobby groups

7. Conclusions and recommendations

This short report has identified potential users of the learning material produced by the Aqua-RET project. These potential uses are wide and varied. However, it is almost inevitably the case that when Aqua-RET is delivered new uses will emerge.

However, based on the preceding discussion, it is possible to identify some challenges and make a number of recommendations;

- The renewable energy sector is rapidly evolving. Wave and tidal current technologies are going through a phase of rapid technological development and our understanding of impacts on the environment and other sea users is embryonic. On one hand this creates a need for a resource like Aqua-RET. Equally it means that content will quickly date. A process for reviewing, and updating the content will be required in order to maintain the value of the project. Obsolescence is arguably the single largest threat the continued relevance of Aqua-RET.
- It would be worth working with primary and secondary teachers in individual countries to match Aqua-RET material with the curriculum and work up specific case studies and examples that could be extracted and applied in the classroom. At the moment there is a great deal of useful information contained within Aqua-RET but individual teachers would need to mine the available information in order to identify specific material relevant to their needs.
- It would be useful to develop quizzes and less formal material targeted at the youngest learners.
- Some form of test certification may increase the potential market for CPD. The European Computer Driving Licence may be a relevant model.
- Raising the initial profile of the material will be a challenge. One of the strengths of the material is the potentially broad audience. However this strength also makes informing the audience challenging. It may be useful to target professional associations, teachers' organisations/associations and teaching colleges to raise brand awareness. Strategies for maximising web hits will be vital. Once a critical level of use is reached, and a good reputation established, Aqua-RET's profile may become self sustaining.