

The 8th European Wave and
Tidal Energy Conference

EWTEC 2009

CONFERENCE PROGRAMME

Uppsala, Sweden
7–10 September 2009

Welcome to EWTEC 2009

As chairman of the Organisational and Advisory Committees, it is my pleasure to welcome you all to the 8th European Wave and Tidal Energy Conference, organised by the Division of Electricity at Uppsala University. The first conference in this series was held in Edinburgh in 1993.

This year, 133 papers have been selected for inclusion in the Conference Proceedings following an intense peer-review process. Some of these papers will be presented during a Poster Session, which is a novelty compared to the last conference in Porto 2007. Conventional oral presentations will be made of 108 papers. The programme also offers the usual social events and some very interesting Technical Tours. Industrial representatives from the field of renewable energy are here to exhibit their products. In all, this promises to be a most rewarding conference for everyone involved.

I wish to express my gratitude to the EWTEC Technical Committee, all reviewers, our sponsors and not least to the local EWTEC 2009 Organising Team for their contributions in arranging the 8th European Wave and Tidal Energy Conference. Once again, welcome to Uppsala and to the conference!

Mats Leijon

Professor of Electricity, Uppsala University

Chairman of the EWTEC 2009 Organisational and Advisory Committees



UPPSALA
UNIVERSITET

Division of Electricity
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Uppsala University
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Conference Organisation

Organisational Committee (Uppsala University)

- Prof. Mats Leijon (chairperson)
- Dr. Marcus Berg (organisation)
- Prof. Sven Israelsson
- Dr. Jan Sundberg
- Dr. Rafael Waters
- M.Sc. Halvar Gravråkmö

Advisory Committee

- Prof. Mats Leijon (chairperson), Uppsala University, Sweden
- Prof. AbuBakr Bahaj, University of Southampton, UK
- Prof. Lars Bergdahl, Chalmers University of Technology, Sweden
- Prof. António Falcão, Instituto Superior Técnico, Portugal
- Dr. Cameron Johnstone, University of Strathclyde, UK
- Dr. Tony Lewis, University College Cork, Ireland

Technical Committee

- Prof. António Falcão, Instituto Superior Técnico, Portugal
- Prof. AbuBakr Bahaj, University of Southampton, UK
- Dr. Alain Clément, École Central de Nantes, France
- Dr. Andrew Grant, University of Strathclyde, UK
- Prof. António Sarmiento, Wave Energy Centre, Portugal
- Dr. Cameron Johnstone, University of Strathclyde, UK
- Dr. Gareth Thomas, University College Cork, Ireland
- Dr. Georgios Lemonis, Centre for Renewable Energy Sources, Greece
- Dr. Henk Polinder, Delft University of Technology, The Netherlands
- Prof. Ian Bryden, University of Edinburgh, UK
- Prof. Johannes Falnes, Norwegian University of Science and Technology, Norway
- Dr. Kim Nielsen, Rambøll, Denmark
- Prof. Lars Bergdahl, Chalmers University of Technology, Sweden
- Prof. Luís Gato, Instituto Superior Técnico, Portugal
- Prof. Marc Vantorre, Ghent University, Belgium
- Prof. Mats Leijon, Uppsala University, Sweden
- Dr. Peter Frigaard, Aalborg University, Denmark
- Prof. Spyros Mavrakos, National Technical University of Athens, Greece
- Prof. Stephen Salter, University of Edinburgh, UK
- Dr. Teresa Pontes, Instituto Nacional de Engenharia, Tecnologia e Inovação, Portugal
- Dr. Tony Lewis, University College Cork, Ireland
- Prof. Trevor Whittaker, Queen's University of Belfast, UK

EWTEC at a glance

Conference Topics

EWTEC 2009 covers the following topics. Oral sessions are assigned a corresponding roman numeral.

1. Preferential subject A: Grid connection and system aspects of wave and marine current power
2. Preferential subject B: Future markets and ocean energy financing
3. Wave and tidal energy resource characterization
4. Device development and testing
5. Device hydrodynamics and structural mechanics
6. Power take-off and device control
7. Device and environmental modelling
8. Testing standards and performance normalization
9. Environmental impact and appraisal
10. Policy development and legislation
11. Socio-economic impact

Information Desk

The Information Desk is located on the ground floor of Uppsala Castle.

Telephone: 072-203 78 00 (local)
+46 72 203 7800 (international)

Lunch

Lunch is served at Norrland's Nation, situated by the *Fyrisån* river in central Uppsala. See the map on page 8. Lunch hours are as follows:

Tuesday	11.00–12.30
Wednesday	12.00–13.30
Thursday	11.30–13.00

Vegetarian food and other special food requirements will be available according to requests made upon registration. For admittance, please wear your EWTEC 2009 nametag clearly visible when entering the Nation.

Note. Norrland's Nation is situated downhill from Uppsala Castle. Please allow ten minutes for the walk there, and slightly more for the return which is uphill. Afternoon sessions will start promptly on time.

Refreshments

Coffee and other refreshments will be available outside the session rooms and in the Adolf Fredrik room during oral sessions. There are no explicitly scheduled refreshment breaks, but feel free to grab a cup of coffee during an inter-session break and bring it with you to the next session.

Monday 7 September

Tuesday 8 September

8.30–10.30

OPENING SESSION

Uppsala University main building
See page 5

11.00–12.30

LUNCH

Norrland's Nation

12.30–16.15

ORAL SESSIONS

Uppsala Castle

I Preferential subject A: Grid connection and system aspects of wave and marine current power

III-A Wave and tidal energy resource characterization 1

IV-A Device development and testing 1

V-A Device hydrodynamics and structural mechanics 1

VII-A Device and environmental modelling 1

X Policy development and legislation

See page 11

16.30–18.30

POSTER SESSION

Main hall, Uppsala Castle

See page 12

15.00 Check-in opens at Uppsala Castle

17.00–20.00

WELCOME RECEPTION

Main hall, Uppsala Castle

See page 5

Wednesday 9 September	Thursday 10 September	Friday 11 September
8.10–11.55		
ORAL SESSIONS Uppsala Castle III-B Wave and tidal energy resource characterization 2 IV-B Device development and testing 2 IV-C Device development and testing 3 V-B Device hydrodynamics and structural mechanics 2 VI-A Power take-off and device control 1 XI Socio-economic impact <i>See page 13</i>	9.00–11.25 ORAL SESSIONS Uppsala Castle IV-D Device development and testing 4 V-C Device hydrodynamics and structural mechanics 3 VI-B Power take-off and device control 2 <i>See page 14</i>	
	11.30–13.00	
12.00–13.30	LUNCH Norrländ's Nation	
	13.00–15.25	
13.30–15.55	ORAL SESSIONS Uppsala Castle V-D Device hydrodynamics and structural mechanics 4 VII-C Device and environmental modelling 3 IX Environmental impact and appraisal <i>See page 15</i>	TECHNICAL TOURS <i>See page 7</i>
	15.45–17.00	
	CLOSING SESSION Main hall, Uppsala Castle <i>See page 5</i>	
19.00 (until late)		
CONFERENCE DINNER Uppsala Castle <i>See page 5</i>		

VATTENFALL OCEAN ENERGY PROGRAMME

We believe that Ocean Energy will be the next renewable technology to be commercialised within 10 to 15 years. Our concern for the climate and the environment is one of the reasons why we are focusing on wave energy.

The aim with Vattenfall's Ocean Energy Programme is to reach a fast breakthrough and to meet the demands and expectations of our customers.

Read more at www.vattenfall.se or at www.vattenfall.com

Conference Highlights

Welcome Reception

On Monday evening at 17.00–20.00, you will have the chance to socialize with old friends and meet new acquaintances at the EWTEC 2009 Welcome Reception in the Main hall of Uppsala Castle, in the presence of the most famous of all Uppsala scholars, Dr. Carolus Linnaeus. The bar will be open and some light entertainment provided.

Opening session

The Opening Session of EWTEC 2009 will be held on Tuesday 8 September at 8.30–10.30 in the assembly hall of the Uppsala University main building (see the map on page 8). The list of speakers will include prominent representatives from academia, government and industry within the field of renewable energy. A detailed programme will be issued separately.



Photo: Martin Celje

Uppsala University

Uppsala University, the first university in Scandinavia, was founded in 1477 by initiative of the Primate of the Catholic Church of Sweden, Archbishop Jakob Ulvsson of Uppsala. After a period of decay during the Lutheran Reformation, the privileges of the University were restored and a new charter signed in 1595.

Many famous scholars and scientists have studied, lectured and performed their research at Uppsala University. In the late 17th century, Olof Rudbeck constructed his remarkable anatomical theatre in the *Gustavianum* building, today the University Museum. The astronomer Anders Celsius became professor at Uppsala in 1730, the botanist Carolus Linnaeus in 1741. In the 19th and early 20th centuries, Anders Ångström and his son Knut Ångström were professors of physics, and the modern Ångström Laboratory is named in their memory. Through the years, eight Nobel laureates have been connected to the University.

The present-day main building of the University, University Hall, was a gift by the government to the University on its 400th anniversary in 1877. It was constructed in the following decade and inaugurated in 1887. In the park in front of the building, a statue of the 19th century historian Erik Gustaf Geijer, at the time regarded as the foremost of the University's scholars, was erected.

Today, Uppsala University is organised in nine faculties: theology, law, arts, languages, social sciences, educational sciences, medicine, pharmacy, and science and technology. The University has 6 000 employees, two-thirds of which are academic staff. There are more than 40 000 graduate and undergraduate students, including 2 000 doctoral students. Uppsala University is highly rated in international rankings and comparisons with other universities at home and abroad.

Conference Dinner

On Wednesday night you are invited to the Castle for a traditional Uppsala *sittning*, which is a formal dinner party followed by dancing to live music. Many *sittning* traditions are influenced by the student lifestyle which has put its mark on Uppsala since 1477. Among other things, the evening will contain food and drinks (including snaps), as well as singing.

For those of you interested, opportunities will also be given to contribute to the entertainment with your talents of all kinds, be they ever so small. Musical performances, funny stories, show dancing – everything is equally welcome. If you want to perform during the dinner, please contact one of the toastmasters (Simon Tyrberg or Katarina Yuen) or leave a note at the Information Desk. After the dinner, an open stage with instruments and microphones will be provided, as will encouraging cheers and applause. A contribution might be the quickest way to fame within the EWTEC community, so don't miss out. Surveys show that that a half-bad *sittning*-performance tends to be 54 % more successful than a half-good conference presentation.

The evening begins with a welcome drink at 19.00! Dinner seating is at 19.20. The dress code is informal dress.

Note. The Conference Dinner is included in the conference fee for all participants.

Closing session

During the joint Closing Session on Thursday 10 September at 15.45–17.00 in the Main hall at Uppsala Castle, a discussion will be held regarding EWTEC 2009 and future European Wave and Tidal Energy Conferences. Come and give your input.



Photo: Marcus Marcell

Uppsala Castle

The construction of Uppsala Castle was begun by King Gustavus Vasa in the mid-16th century as a fortification against foreign as well as domestic enemies. Over the decades, the Castle was remodelled and expanded into a representative renaissance palace, and it was traditionally used for the festivities following the coronation of a new monarch in the Uppsala Cathedral. The Castle was damaged in the great Uppsala city fire of 1702, and parts of the building were torn down and used for construction material in other buildings. Eventually, the Castle was reconstructed in a French classical style. Due to funding reasons, the planned north wing was never constructed, and this is the way Uppsala Castle looks today.

Through the centuries, Uppsala Castle has been the site of many significant events in Swedish history, among them the decision by the Privy Council in 1629 to enter into the Thirty Years' War and the abdication of Queen Christina in 1654. Today, the Castle houses the residence of the county governor, and three museums are open to the public.



DDB Oslo W20 Photo: Petrus Olsson

The future needs less fossil fuels. That is why we are developing tidal power in the north sea.

The European countries have committed themselves to an ambitious goal to reduce their carbon emissions. This will require the construction of new renewable energy power plants. Statkraft has generated hydropower for more than 100 years and today marine energy and wind power are

also important focus areas for power production. Statkraft is Europe's largest renewable energy company, and since the world's need for pure energy will continue to grow, so will we. Read more at www.statkraft.com

The future looks bright.



Technical Tours

All Technical Tours take place on Friday 11 September.

Late registration. There are limitations to the number of participants on some tours. If you did not register for a tour in advance but would still like to go, please enquire at the Information Desk about any vacancies on that tour. Empty slots will be filled on a first come, first served basis.

Forsmark Nuclear Waste Storage and Älvkarleby Hydraulic Lab

This tour comprises study visits to the Underground Facility for Nuclear Waste Storage at Forsmark Nuclear Power Plant and to Vattenfall's Hydraulic Laboratory at the Älvkarleby research facility.

Important information for participants. If you already registered for this tour, you must complete the tour sign-up with your passport number at the Information Desk *no later than Wednesday 9 September at 11.00*. The Swedish Nuclear Fuel and Waste Management Company requires this information for all persons entering their underground facilities. Late registration for this tour will not be possible after 11 o'clock on Wednesday.

The tour fee is 15 €.

Preliminary tour schedule

- 7.30 Departure by bus from the parking lot beside the Botanic Garden (right across the street from Uppsala Castle)
- 9.00 Study visit to the Facility for Nuclear Waste Storage and the Biotest Lake
- 12.30 Lunch at the Forsmark Guesthouse (included in the tour)
- 13.30 Departure by bus to the Älvkarleby Research facility
- 14.30 Study visit to the Hydraulic Laboratory in Älvkarleby
- 15.30 Departure by bus for Uppsala
- 17.00 Return to Uppsala

Lysekil Wave Power Plant

This technical tour features a study visit to the Uppsala University Wave Power research facility outside Lysekil on the Swedish west coast. The site is about 460 km from Uppsala and this will be a full day trip. Breakfast/lunch will be provided on the morning trip and a dinner stop will be taken on the return trip to Uppsala. Departure directly for Gothenburg after the visit in Lysekil is possible (for onward flights abroad etc.).

Please note that the bustrip back and forth to Lysekil takes 12 h!

The tour fee is 30 €.

Preliminary tour schedule

- 5.00 Departure by bus, central Uppsala
- 45 min break
- 12.00 Arrival in Lysekil
- 12.30 Boat tour out to the wave power site Islandsberg
- 14.00 Return to Lysekil
- 14.30 Visit to Seabased Industry work shop
- 16.00 Departure for Uppsala
- 45 min dinner break
- 23.55 Arrival in Uppsala

Note: Detailed information regarding bus departure locations etc. will be provided separately.

Marsta Wind Turbines

During this field trip you will see a short demonstration of a 12 kW vertical axis wind turbine at a research facility located north of Uppsala. The turbine is directly connected to a permanent magnet generator and operates at variable speed. After the demonstration we will head on to Old Uppsala, an area rich in archaeological remains. We will visit the local museum and nearby burial mounds. This is a half day event.

Important information for participants. There are no toilets or water available at the wind turbine site. However, these facilities are provided at the museum and restaurant.

The tour fee is 15 €.

Preliminary tour schedule

- 9.30 Departure by bus from the parking lot beside the Botanic Garden (right across the street from Uppsala Castle)
- 10.00 Demonstration of the vertical axis wind turbine
- 11.00 Bus leaves for Old Uppsala
- 11.20 Guided tour of the local museum and burial mounds
- 12.45 Lunch buffet (included in the tour) with optional mead (55 SEK per bottle)
- 13.45 Departure for Uppsala
- 14.15 Return to Uppsala

ABB

This tour is a study visit to the ABB facilities in Ludvika. ABB is one of the main suppliers of both power and automation technology necessary for the renewable energy industry. ABB products and know-how are used across the energy chain, from power generation and power plant control to grid connections and transmission. ABB technologies, such as FACTS and HVDC, not only allow the connection of intermittent energy sources to the grid without stability problems but also make it possible to locate large off shore wind farms far from the coast. On this tour you will be given the opportunity to see some of the latest developments necessary for large scale integration of renewable energy sources.

The tour fee is 15 €.

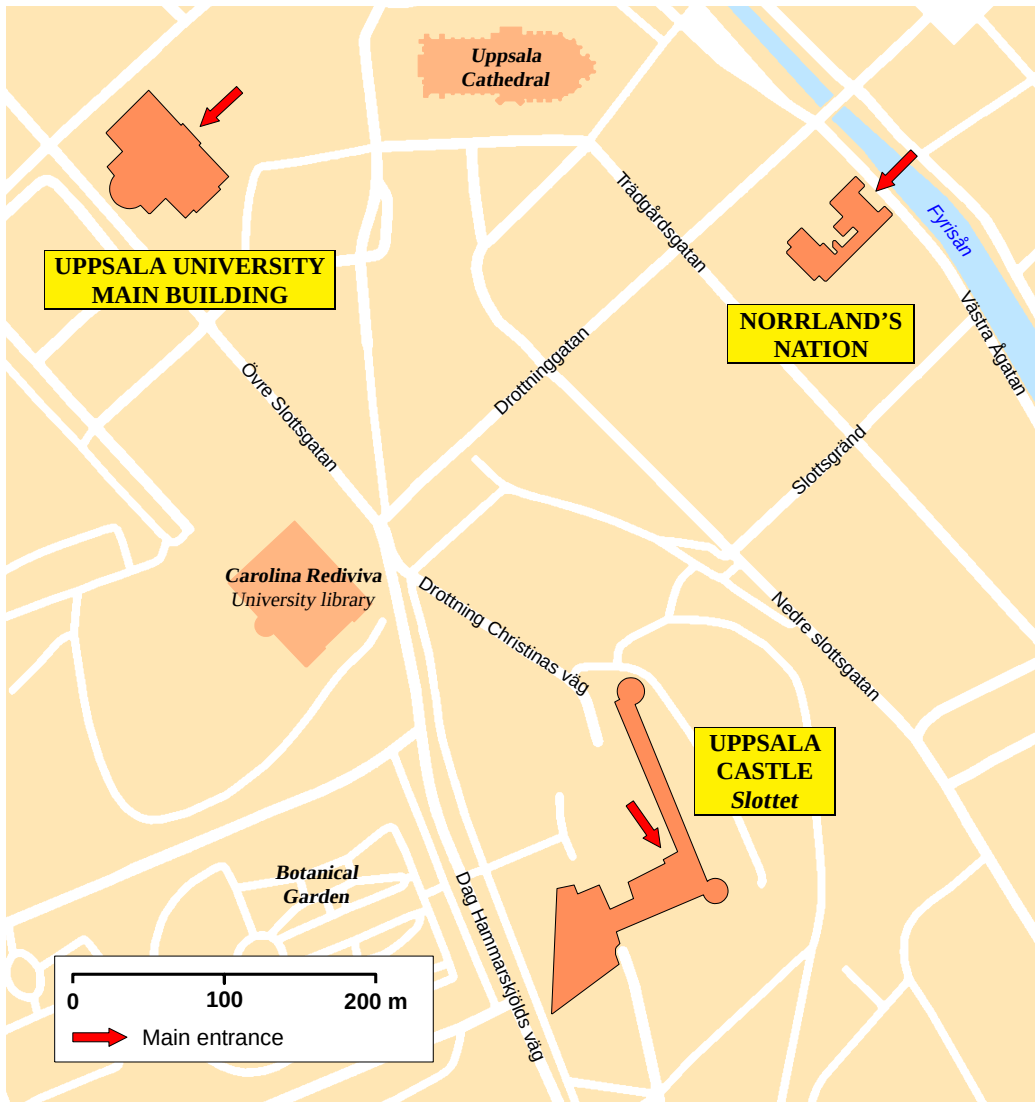
Preliminary tour schedule

- 7.00 Departure by bus from the parking lot beside the Botanic Garden (right across the street from Uppsala Castle)
- 10.00 Study visit ABB
- 12.00 Lunch (included in the tour)
- 13.00 Study visit ABB High Voltage Laboratory
- 15.00 Return to Uppsala
- 17.00 Arrival in Uppsala



Photo: Division of Electricity

Where to go



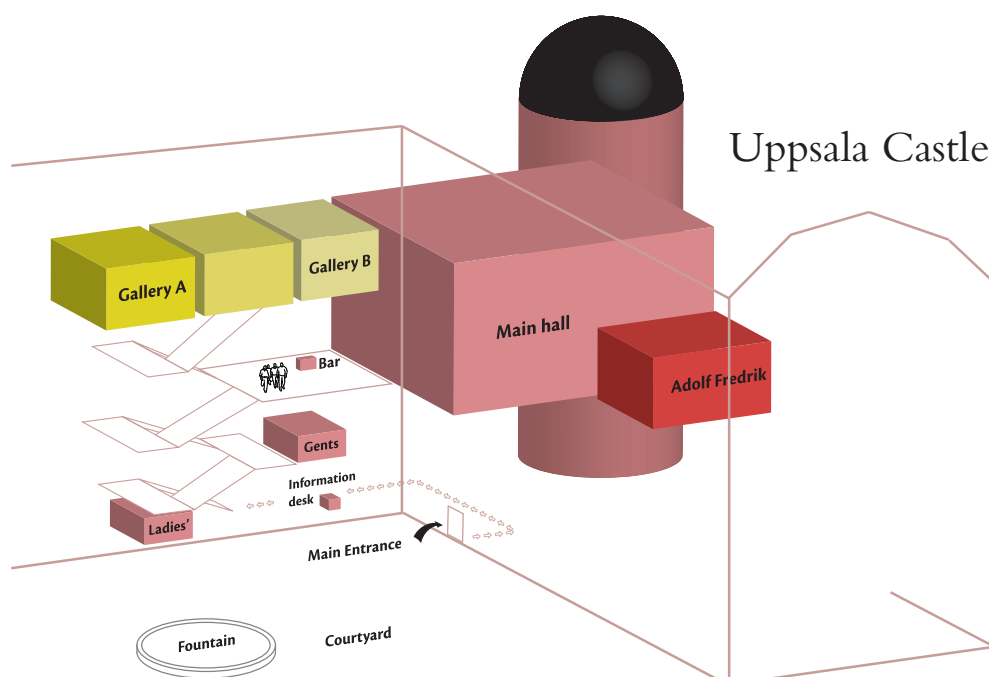
The assembly hall of the **Uppsala University main building** is the site of the Opening Session.



Norrland's Nation is our lunch site. Enter from the street by the small river, between the cinemas *Spegeln* and *Filmstaden*.



Uppsala Castle, Slottet in Swedish, is the main venue of the conference. For a plan of the castle, see below.



Industrial Exhibition

Several commercial companies and other organisations are participating in the conference by displaying their products and services at Uppsala Castle. Some booths are located in the Adolf Fredrik room, others in the hallways and between the galleries on the top floor. See the Castle plan



on page 8. Among others, the following distinguished actors in the field of renewable energy are represented:

Main Sponsors

- Vattenfall (see advertisement on page 4)
- Statkraft (see advertisement on page 6)
- Fortum (see advertisement on page 10)

Other Sponsors

- Seabased (see advertisement on page 16)

Other Exhibitors

- Sandvik
- Trelleborg
- Garrad Hassan
- Aquatera
- INORE

Technical Programme

Oral Sessions

Oral presentations will take place concurrently in three rooms, the Main hall, Gallery A and Gallery B. The Sessions will be chaired by members of the EWTEC Technical Committee. For a detailed programme, see pages 11 and 13–15. Abstracts of all papers presented orally can be found in the *EWTEC 2009 Book of Abstracts*; reference is made in the detailed programme as *BoA p. XX*.

Instructions to presenting authors. In each session room, a computer and projector will be provided to facilitate presentations. The recommended format to use is PDF, although PowerPoint will also be supported. Please note that it will **not** be possible to connect your own computer during the session!

Presentations are to be handed in at the Information Desk, preferably when you check into the conference but no later than specified below:

<i>Time of presentation</i>	<i>Sessions</i>	<i>Latest hand-in time</i>
Tuesday afternoon	I, III-A, IV-A, V-A, VII-A, X	Tuesday 12.00
Wednesday morning	III-B, IV-B, IV-C, V-B, VI-A, XI	Wednesday 7.45
Wednesday afternoon	II, III-C, VII-B	Wednesday 13.00
Thursday morning	IV-D, V-C, VI-B	Thursday 8.30
Thursday afternoon	V-D, VII-C, IX	Thursday 12.30

Bring your presentation on a USB memory device. As you hand in your presentation, it will be checked to ensure it is working properly. It will then be available on the computer provided in the session room.

Please make sure to hand in your presentation well in advance. This will ensure smooth switching of presentations during sessions. Presentations that are not handed in on time will not be available in the session room. Again, it will not be possible for you to connect your own computer.

The time available for each paper is 15 minutes presentation followed by 5 minutes questions and discussion. Please make sure that you plan your presentation within the allotted time frame.

Poster Session

The Poster Session will be held on Tuesday 8 September at 16.30–18.30 in the Main hall at Uppsala Castle. It will be opened with a brief introduction by the Session Chair. There will then be time to walk around and study the posters and chat with authors. For a detailed programme, see page 12. Abstracts of all papers presented on posters can be found in the *EWTEC 2009 Book of Abstracts*; reference is made in the detailed programme as *BoA p. XX*.

During the session, the bar will be open and some light snacks provided.

Instructions to presenting authors. You will have time to put up your posters on an allocated space (identified by the title of your paper) on Monday at 15.00–17.00 and on Tuesday at 8.00–12.00. A minimum of one author per poster is expected to be present with each poster during the Poster Session to explain the presentation and answer attendees' questions. If you would like to keep your poster, you must take it with you at (but not before) the end of the Poster Session.





How much energy does an ocean wave contain? Fortum, together with Uppsala University, are currently testing a new type of wave-power plant outside Lysekil, on the Swedish west coast. Buoys move up and down according to the motions of the ocean, and a connected generator on the sea bed converts the power of the waves into electricity. Calculations show that wave power can cover up to 10% of the world's entire energy needs and our experimental facility is capable to cover the energy requirement for 20 households. A good start.

Tuesday 8 September 2009, afternoon programme

Main hall

Session hours 12.30–13.35

X. Policy development and legislation

Session chair: Dr. Andrew Grant

Ocean Energy Systems Implementing Agreement: A New Collaborative Activity on Environmental Issues (BoA p. 69)

J. Huckerby, A. Moreno, W. Musial, A. Brito-Melo

Review and discussion of common environmental legislation for ocean energy schemes (BoA p. 69)

T. C. Simas, A. C. Moura, S. Patrício, R. Batty

Methodology for site selection for wave energy projects (BoA p. 70)

L. Zubiate, J. L. Villate, Y. Torre-Enciso, H. C. Soerensen, B. Holmes, M. Panagiotopoulos, F. Neumann, N. Rosseau, D. Langston

Gallery A

III-A. Wave and tidal energy resource characterization 1

Session chair: Prof. AbuBakr Bahaj

Comparison of measured shallow-water wave spectra with theoretical spectra (BoA p. 12)

L. Bergdahl

Assessing the Wave Energy Resource Using Remote Sensed Data (BoA p. 12)

M. T. Pontes, M. Bruck, S. Lehner

Determination of sea conditions for wave energy conversion by spectral analysis (BoA p. 13)

B. Yagci, P. Wegener

Gallery B

VII-A. Device and environmental modelling 1

Session chair: Prof. Stephen Salter

Numerical modeling of a river site for in-stream energy converters (BoA p. 55)

E. Lalander, M. Leijon

Experimental and Computational Analysis of a Model Horizontal Axis Tidal Turbine (BoA p. 55)

T. O'Doherty, A. Mason-Jones, D. M. O'Doherty, C. B. Byrne, I. Owen, Y. Wang

The Effect of Boundary Conditions on Performance Prediction Model Results for Tidal Turbines (BoA p. 56)

N. E. Turner, A. Owen

15 min break

Session hours 13.50–14.55

I. Preferential subject A: Grid connection and system aspects of wave and marine current power

Session chair: Dr. Cameron Johnstone

Challenges in the Grid Connection of Wave Energy Devices (BoA p. 5)

D. L. O'Sullivan, G. Dalton

Is it a showstopper? Reliability assessment and criticality analysis for Wave Energy Converters (BoA p. 5)

P. R. Thies, J. Flinn, G. H. Smith

Development of the French Wave Energy Test Site SEM-REV (BoA p. 6)

H. Mouslim, A. Babarit, A. Clément, B. Borgarino

III-A. Wave and tidal energy resource characterization 1 (continued)

Variability of Wind Sea and Swell Waves in the North Atlantic Based on ERA-40 Re-analysis (BoA p. 13)

A. Semedo, K. Sušelj, A. Rutgersson

Numerical Estimation of Incident Wave Parameters Based on the Air Pressure Measurements in Pico OWC Plant (BoA p. 14)

I. Le Crom, A. Brito-Melo, F. Neumann, A. Sarmiento

A new methodology to evaluate wave energy resources in intermediate depths. Application to the Asturias coast (North Spain) (BoA p. 14)

P. Camus, C. Vidal, F. J. Méndez, A. Espejo, B. G. Reguero

IV-A. Device development and testing 1

Session chair: Dr. Tony Lewis

A Parametric Experimental Study of the 2D Performance of a Ducted Wave Energy Converter (BoA p. 22)

M. T. Leybourne, W. M. J. Batten, A. S. Bahaj, J. O'Nians, N. Minns

Performance optimisation of a modified Duck through optimal mass distribution (BoA p. 22)

J. Lucas, S. H. Salter, J. Cruz, J. Taylor, I. G. Bryden

Development of advanced wave power generation system by applying gyroscopic moment (BoA p. 23)

H. Kanki, S. Arii, T. Furusawa, T. Ootoyo

15 min break

Session hours 15.10–16.15

I. Preferential subject A: Grid connection and system aspects of wave and marine current power (continued)

Comparing the electrical transmission systems for Archimedes Wave Swing parks (BoA p. 6)

B. Czech, P. Bauer, H. Polinder, Y. Zhou, P. Korondi

Description of the control and measurement system used in the Low Voltage Marine Substation at the Lysekil research site (BoA p. 7)

O. Svensson, C. Boström, M. Rahm, M. Leijon

Laboratory Experimental Verification of a Marine Substation (BoA p. 7)

M. Rahm, C. Boström, O. Svensson, M. Grabbe, F. Bülow, M. Leijon

V-A. Device hydrodynamics and structural mechanics 1

Session chair: Prof. Stephen Salter

Hydrodynamic modelling of a vertical axis tidal current turbine using CFD (BoA p. 34)

G. I. Greston, T. Bruce, D. M. Ingram

A parameter study of the influence of struts on the performance of a vertical-axis marine current turbine (BoA p. 34)

A. Goude, S. Lundin, M. Leijon

Influence of Solidity on the Performance of a Cross-Flow Turbine (BoA p. 35)

C. A. Consul, R. H. J. Willden, E. Ferrer, M. D. McCulloch

IV-A. Device development and testing 1 (continued)

In field measurements on a small scale OWC device (BoA p. 23)

P. Filianoti, S. M. Camporeale

Statistical analysis of power production from OWC type wave energy converters (BoA p. 24)

L. Martinelli, B. Zanutigh, J. P. Kofoed

Practical design and investigation of the breakwater OWC facility in China (BoA p. 24)

Z. Liu, H. Shi, B.-S. Hyun

Note: BoA references the EWTEC 2009 Book of Abstracts

Tuesday 8 September 2009, evening programme

Main hall

Session hours 16.30–18.30

XII. Poster session

Session chair: Prof. AbuBakr Bahaj, Prof. Mats Leijon

Wave and tidal energy resource characterization

- Analysis and Comparison of Tidal Datasets (BoA p. 19)
A. Sankaran Iyer, S. J. Couch, G. P. Harrison, A. R. Wallace
- Spatial & Spectral Variation of Seaways (BoA p. 19)
S. Barrett, I. Ashton, T. Lewis, G. H. Smith
- Wave energy resource off the French coasts: the ANEMOC database applied to the energy yield evaluation of Wave Energy Converters (BoA p. 20)
G. Mattarolo, F. Lafon, M. Benoit
- Assessment of Wave Energy around Italy (BoA p. 21)
D. Vicinanza, L. Cappietti, P. Contestabile

Device development and testing

- The bioSTREAM tidal current energy converter (BoA p. 31)
G. Kloos, C. A. Gonzales, T. D. Finnigan
- Considerations of Improved Tidal Stream Turbine Performance Using Double Rows of Contra-Rotating Blades (BoA p. 32)
D. M. O'Doherty, A. Mason-Jones, T. O'Doherty, C. B. Byrne
- Design and Construction of an Experimental Wave Energy Device Emulator Test Rig (BoA p. 32)
J. Duquette, D. L. O'Sullivan, S. Ceballos, R. Alcorn
- Prototype test and modeling of a combined wave and wind energy conversion system (BoA p. 33)
B. S. Kalløse, F. H. Diken, H. F. Hansen, A. Köhler
- OCEANTEC: Sea Trials of a Quarter Scale Prototype (BoA p. 33)
F. Salcedo, P. Ruiz-Minguela, R. Rodriguez, P. Ricci, M. Santos

Device hydrodynamics and structural mechanics

- Investigation of the Influence of Array Arrangement and Spacing on Tidal Energy Converter (TEC) Performance using a 3-Dimensional CFD Model (BoA p. 44)
L. Bai, R. R. G. Spence, G. Dudziak
- Experimental study to determine flow characteristic effects on marine current turbine behaviour (BoA p. 45)
F. Maganga, G. Germain, J. King, G. Pinon, E. Rivoalen
- Torque ripple and variable blade force: A comparison of Darrieus and Gorlov-type turbines for tidal stream energy conversion (BoA p. 45)
J. D. Winchester, S. D. Quayle

Hydraulic circuit description of the MGR Wave Energy Converter (BoA p. 46)

- J. L. Osa Amilibia, E. Zulueta Guerrero
- Reduction of the Tip Clearance Effect in a Radial Impulse Turbine for Wave Energy Conversion (BoA p. 46)
B. Pereiras, J. G. Gonzalez, F. Castro, A. el Marjani, M. A. Rodriguez

Power take-off and device control

- Stochastic, time domain models and Pontryagin Maximum Principle for a two body wave power device (BoA p. 53)
J. J. Cândido, P. A. P. Justino
- Performance of closely spaced point absorbers with constrained floater motion (BoA p. 53)
G. De Backer, M. Vantorre, C. Beels, J. De Rouck, P. Frigaard
- Experimental methods for Power Take-off (PTO) simulation of a Wave Energy Converter (WEC) (BoA p. 54)
N. M. Ferreira, M. D. Hadden

Device and environmental modelling

- Numerical simulation of wake effects in the lee of a farm of Wave Dragon wave energy converters (BoA p. 62)
C. Beels, P. Troch, K. De Visch, G. De Backer, J. De Rouck, J. P. Kofoed
- Numerical Modelling of a Surging Point Absorber Wave Energy Converter (BoA p. 62)
M. A. Bhinder, C. G. Mingham, D. M. Causon, M. T. Rahmati, G. A. Aggidis, R. V. Chaplin
- Influences of wave directionality on a generic point absorber (BoA p. 62)
J.-C. Gilloteaux, J. Ringwood
- Modelling of the MGR Wave Energy Converter (BoA p. 63)
J. L. Osa Amilibia, E. Zulueta Guerrero
- Prediction of the individual wave overtopping volumes of a wave energy converter using physical modeling and first numerical model results (BoA p. 63)
L. Victor, P. Troch, J. P. Kofoed

Testing standards and performance normalization

- Toward reliable production estimation from Wave Energy Converters (BoA p. 64)
R. Pascal, I. G. Bryden

Environmental impact and appraisal

- Numerical modelling of the response of tidal resonance to the presence of a barrage (BoA p. 68)
L. Finlay, S. J. Couch, D. M. Ingram

Policy development and legislation

- Recent developments in wave energy along the coast of southern Africa (BoA p. 70)
J. R. Joubert, J. L. van Niekerk

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Gallery B

Session hours 8.10–9.15	
IV-B. Device development and testing 2 <i>Session chair: Dr. Gareth Thomas</i> Modification of power characteristics in an array of floating wave energy devices (BoA p. 25) B. F. M. Child, V. Venugopal	IV-C. Device development and testing 3 <i>Session chair: Prof. Luís Gato</i> Experimental Testing of the Transverse Horizontal Axis Water Turbine (BoA p. 27) R. A. McAdam, G. T. Houlshy, M. L. G. Oldfield, M. D. McCulloch
Mutriku Wave Power Plant: from the thinking out to the reality (BoA p. 25) Y. Torre-Enciso, I. Ortubia, L. I. López de Aguilera, J. Marqués	Contra-rotating Marine Current Turbines: Single Point Tethered Floating System – Stability and Performance (BoA p. 27) J. Clarke, G. Connor, A. Grant, C. Johnstone, S. Ordonez-Sanchez
A Pilot Study Into the Optimization of the Shape of a Wave Energy Collector by Genetic Algorithm (BoA p. 25) A. P. McCabe, G. A. Aggidis, M. B. Widden	Design of a Gravity Stabilised Fixed Pitch Tidal Turbine of 400 kW (BoA p. 28) C. Freeman, J. Amaral Teixeira, F. Trarieux, R. Ayre

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Session hours 9.30–10.35	
IV-B. Device development and testing 2 (continued)	VI-A. Power take-off and device control 1
Development of Marine Renewable Energy in the South West of England: The Wave Hub and PRIMaRE (BoA p. 26) D. M. Greaves, G. H. Smith, J. Wolfram	<i>Session chair: Prof. Luís Gato</i> Behaviour of a small Wells turbine under randomly varying oscillating flow (BoA p. 47) S. M. Camporeale, P. Filanoti
Foundation load analysis of Oyster using a five degree of freedom load transducer (BoA p. 26) D. Howard, T. Whittaker, K. Doherty	Evolutionary Algorithms for the Development and Optimisation of Wave Energy Converter Control Systems (BoA p. 47) K. Gunn, C. J. Taylor, C. Lingwood
Current and Future Developments of the C-GEN Lightweight Direct Drive Generator for Wave & Tidal Energy (BoA p. 27) N. Hodgins, A. S. McDonald, J. Shek, O. Keysan, M. A. Mueller	Linear and nonlinear modeling and control of a power take-off simulation for wave energy conversion (BoA p. 48) C. J. Taylor, M. A. Stables, P. Cross, K. Gunn, G. A. Aggidis

15 min break

Session hours 10.50–11.55	
XI. Socio-economic impact <i>Session chair: Prof. António Falcão</i> Stakeholder Perceptions of the Wave Hub Development in Cornwall, UK (BoA p. 72) J. West, I. Bailey, I. Whithead	VI-A. Power take-off and device control 1 (continued) Design of a non-linear power take-off simulator for model testing of rotating wave energy devices (BoA p. 48) M. F. P. Lopes, J. C. C. Henriques, M. C. Lopes, L. M. C. Gato, A. Dente
Ocean energy in combination with land-based renewable energy sources: appropriate technology for smaller electricity grids in Africa? (BoA p. 72) L. Hammar, J. Ehnberg, M. Gullström, S. Molander	The influence of a mono-directional PTO on a self-contained inertial WEC (BoA p. 49) H. Bailey, I. G. Bryden
Economic Assessment of Marine Energy Schemes (BoA p. 73) T. Stallard, G. P. Harrison, P. Ricci, J. L. Villate	Investigating the Performance of a Hydraulic Power Take-Off (BoA p. 49) A. R. Plummer, M. Schlotter

Note: BoA references the EWTEC 2009 Book of Abstracts

V-B. Device hydrodynamics and structural mechanics 2
Session chair: Dr. Alain Clément
A level set immersed boundary model for extreme wave impacts on wave energy converters (BoA p. 35)
Y. Zhang, Q. Zou, D. M. Greaves
Extreme Wave Loading on Offshore Wave Energy Devices using CFD: a Hierarchical Team Approach (BoA p. 36)
J. Westphalen, D. M. Greaves, C. K. Williams, P. H. Taylor, D. M. Caulson, C. G. Mingham, Z. Z. Hu, P. K. Stansby, B. D. Rogers, P. Onidvar
Mooring system analysis of multiple wave energy converters in a farm configuration (BoA p. 37)
Z. Gao, T. Moan

V-B. Device hydrodynamics and structural mechanics 2 (continued)
Optimisation of a Heterogeneous Array of Heaving Bodies (BoA p. 37)
S. Bellew, T. Stallard, P. K. Stansby
Assessment of the influence of the distance between two wave energy converters on the energy production (BoA p. 38)
A. Babarit, B. Borgarino, P. Ferrant, A. Clément
Hydrodynamics of triangular-grid arrays of floating point-absorber wave energy converters with inter-body and bottom slack-mooring connections (BoA p. 38)
P. C. Vicente, A. F. de O. Falcão, L. M. C. Gato, P. A. P. Justino

III-B. Wave and tidal energy resource characterization 2
Session chair: Prof. Lars Bergdahl
WorldWaves wave energy resource assessments from the deep ocean to the coast (BoA p. 15)
S. Barstow, G. Mørk, L. Lønseth, J. P. Mathisen
Development and preliminary assessment of an optical wave gauge (BoA p. 15)
G. S. Payne, J.-P. Richon, D. M. Ingram, J. Spinneken
An atmosphere-wave coupled regional climate model (BoA p. 16)
A. Rutgersson, Ø. Setra, A. Semedo, B. Carlsson

Wednesday 9 September 2009, afternoon programme

Main hall	Gallery A	Gallery B
Session hours 13.30–14.35		
II. Preferential subject B: Future markets and ocean energy financing	VII-B. Device and environmental modelling 2	III-C. Wave and tidal energy resource characterization 3
<i>Session chair: Dr. Teresa Pontes</i>	<i>Session chair: Prof. Spyros Mavrakos</i>	<i>Session chair: Prof. António Sarmento</i>
<i>The Development of Alderney's Tidal Resource (BoA p. 8)</i>	<i>Frequency domain techniques for numerical and experimental modelling of wave energy converters (BoA p. 56)</i>	<i>An assessment of tidal energy potential. The Lima estuary (BoA p. 16)</i>
<i>J. E. Antill</i>	<i>A. A. E. Price, C. J. Dent, A. R. Wallace</i>	<i>A. Trigo-Teixeira, I. Rebordão</i>
<i>Non-technical barriers to wave energy development, comparing progress in Ireland and Europe (BoA p. 8)</i>	<i>Hydrodynamics and absorption efficiencies of wavemakers (BoA p. 57)</i>	<i>Tidal current turbine characterisation and energy yield evaluation with Telemac (BoA p. 17)</i>
<i>G. Dalton, N. Rosseau, F. Neumann, B. Holmes</i>	<i>A. E. Maguire, D. M. Ingram</i>	<i>C.-T. Pham, V. A. Martin</i>
<i>Proposed Internationalisation of the UKERC Ocean (Wave and Tidal Current) Renewable Energy Technology Roadmap (BoA p. 9)</i>	<i>Algorithm for the search of the secondary converter optimum impedance in a punctual wave energy converter (BoA p. 57)</i>	<i>A Three-dimensional Hydrodynamic Model of Inland Marine Waters of Washington State, United States, for Tidal Resource and Environmental Impact Assessment (BoA p. 17)</i>
<i>H. Jeffrey, M. A. Mueller, A. R. Wallace</i>	<i>M. C. Paz, D. Simón, J. Porteiro, E. Suarez</i>	<i>M. Kawase, K. M. Thyng</i>

15 min break

Session hours 14.50–15.55	VII-B. Device and environmental modelling 2 (continued)	III-C. Wave and tidal energy resource characterization 3 (continued)
II. Preferential subject B: Future markets and ocean energy financing (continued)	<i>A wear model for assessing the reliability of wave energy converter in heave with hydraulic power take-off (BoA p. 57)</i>	<i>Correcting the Under-estimate of the Tidal-Stream Resource of the Pentland Firth (BoA p. 18)</i>
<i>Hydrokinetic Energy in the United States – Resources, Challenges and Opportunities (BoA p. 10)</i>	<i>L. M. Yang, J. Hals, T. Moan</i>	<i>S. H. Salter</i>
<i>M. Previsic, A. Moreno, R. Bedard, B. Polagye, C. Collar, D. Lockard, W. Toman, S. Skemp, S. Thornton, R. Paasch, R. E. Rocheleau, W. Musial, G. Hagerman</i>	<i>Analysis of potential power output of a device using a wave-by-wave approach (BoA p. 58)</i>	<i>High-resolution metocean modelling at EMEC's (UK) marine energy test sites (BoA p. 18)</i>
<i>Economics of Future U.S. Wave Energy Markets: A Coupled Analysis of Regional Wave Climate and Energy Market Data (BoA p. 10)</i>	<i>H. C. M. Smith, G. H. Smith, V. Venugopal, T. Davey</i>	<i>J. Lawrence, H. Kofoed-Hansen, C. Chevalier</i>
<i>J. G. Vining</i>	<i>Mean Power Output Estimation of WECs in Simulated Sea (BoA p. 58)</i>	<i>Wave and Tidal Power measurement using HF radar (BoA p. 18)</i>
<i>Advances in Hawaii's Ocean Energy RD&D (BoA p. 11)</i>	<i>J.-B. Saulnier, P. Ricci, A. Clément, A. F. de O. Falcão</i>	<i>L. R. Wyatt</i>
<i>A. T. Gill, R. E. Rocheleau</i>		

Thursday 10 September 2009, morning programme

Main hall	Gallery A	Gallery B
Session hours 9.00–10.05		
VI-B. Power take-off and device control 2	V-C. Device hydrodynamics and structural mechanics 3	IV-D. Device development and testing 4
<i>Session chair: Dr. Alain Clément</i>	<i>Session chair: Dr. Andrew Grant</i>	<i>Session chair: Dr. Peter Frigaard</i>
<i>Wave Farm Design: Preliminary Studies on the Influences of Wave Climate, Array Layout and Farm Control (BoA p. 50)</i>	<i>Unsteady 3D Wake Modelling for Marine Current Turbines (BoA p. 38)</i>	<i>Analysis of wave reflection from wave energy converters installed as breakwaters in harbour (BoA p. 28)</i>
<i>J. Cruz, R. K. Sykes, P. Siddorn, R. Eatock Taylor</i>	<i>T. McCombes, C. Johnstone, A. Grant</i>	<i>B. Zanuttigh, L. Margheritini, L. Gambles, L. Martinelli</i>
<i>Control Strategies for a simple Point-Absorber Connected to a Hydraulic Power Take-off (BoA p. 50)</i>	<i>Near wake properties of horizontal axis marine current turbines (BoA p. 39)</i>	<i>Resonating wave energy converter for delivery of water for desalination and energy generation (BoA p. 29)</i>
<i>P. Ricci, J. Lopez, M. Santos, J. L. Villate, P. Ruiz-Minguela, F. Salcedo, A. F. de O. Falcão</i>	<i>L. E. Myers, A. S. Bahaj</i>	<i>D. Magagna, D. Stagonas, D. Warbrick, G. Muller</i>
<i>A Study on Short-Term Sea Profile Prediction for Wave Energy Applications (BoA p. 51)</i>	<i>A comparison between CFD simulations and experiments for predicting the far wake of horizontal axis tidal turbines (BoA p. 39)</i>	<i>Experimental investigation of power capture from pitching point absorbers (BoA p. 29)</i>
<i>F. Fusco, J. Ringwood</i>	<i>M. E. Harrison, W. M. J. Batten, L. E. Myers, A. S. Bahaj</i>	<i>F. Flocard, T. D. Finnigan</i>

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Session hours 10.20–11.25

VI-B. Power take-off and device control 2 (continued)

Integrated Structural and Electrical Design of the Linear Permanent Magnet Synchronous Machine (BoA p. 52)

S. L. Caraher, R. Crozier, A. S. McDonald, M. A. Mueller, J. P. Chick

CFD Analysis of Air Turbines as Power Take-Off Systems in

Oscillating Water Column Wave Energy Conversion Plant (BoA p. 52)

A. Gareev, P. Cooper, P. B. Kosasih

Applications of Supercapacitor Energy Storage for a Wave Energy Converter System (BoA p. 53)

D. B. Murray, M. G. Egan, J. G. Hayes, D. L. O'Sullivan

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V-C. Device hydrodynamics and structural mechanics 3 (continued)

Comparison of boundary-layer and field models for simulation of flow through multiple-row tidal fences (BoA p. 40)

L. S. Blunden, W. M. J. J. Batten, M. E. Harrison, A. S. Bahaj

Inertia Effects on Horizontal Axis Tidal-Stream Turbines (BoA p. 40)

J. I. Whelan, J. M. R. Graham, J. Peiró

An experimental study to assess the potential benefits of foundation based flow acceleration structures for marine current energy converters (BoA p. 41)

J. Giles, L. E. Myers, A. S. Bahaj, J. O'Nians

IV-D. Device development and testing 4 (continued)

Development of a multi-bladed 250 kW pitching wave-energy converter (BoA p. 30)

C. A. Gonzales, G. Kloos, T. D. Finnigan

Wavebob – Research & Development Network and Tools in the Context of Systems Engineering (BoA p. 30)

J. Weber, F. Mouwen, A. Parish, D. Robertson

The Ocean Harvester – Modelling, Simulation and Experimental Validation (BoA p. 31)

M. Sidenmark, A. Josefsson, A. Berghuvud, G. Broman

Thursday 10 September 2009, afternoon programme

Main hall

Gallery A

Gallery B

Session hours 13.00–14.05

IX. Environmental impact and appraisal

Session chair: Dr. Tony Lewis

Underwater Noise Modelling of Wave Energy Devices (BoA p. 65)

S. Patrício, C. Soares, A. Sarmento

Environmental Monitoring at the Maren Wave Power Test Site off the Island of Runde, Western Norway: Planning and Design (BoA p. 65)

K. Andersen, A. Chapman, N. R. Hareide, A. O. Folkestad, E. Sparrevik,

O. Langhammer

A 20 GW Thermal 300-metre³/sec Wave-energised, Surge-mode

Nutrient-pump for Removing Atmospheric Carbon dioxide,

Increasing Fish Stocks and Suppressing Hurricanes (BoA p. 66)

S. H. Salter

V-D. Device hydrodynamics and structural mechanics 4

Session chair: Prof. António Falcão

Float Design to Limit Displacement in Severe Seas (BoA p. 41)

T. Stallard, P. K. Stansby, S. Weller, A. C. Williamson

Hydrodynamic Optimization of the Active surface of a Heaving Point Absorber WEC (BoA p. 41)

M. Alves, A. Sarmento

A hydrodynamic study of a floating circular OWC (BoA p. 42)

R. K. Sykes, A. W. Lewis, G. P. Thomas

VII-C. Device and environmental modelling 3

Session chair: Dr. Gareth Thomas

Research for evaluating performance of OWC-type Wave Energy Converter “Backward Bent Duct Buoy” (BoA p. 59)

K. Toyota, S. Nagata, Y. Inai, T. Setoguchi

Experimental verification of the stochastic model for predicting the performance of Oscillating Water Columns devices (BoA p. 59)

S. M. Camporeale, P. Filianoti

Modelling and Analysis of an Offshore Oscillating Water Column Wave Energy Converter (BoA p. 60)

D. P. Cashman, D. L. O'Sullivan, M. G. Egan, J. G. Hayes

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Session hours 14.20–15.25

IX. Environmental impact and appraisal (continued)

Modelling Tidal Energy Extraction in a Depth-Averaged Coastal Domain (BoA p. 66)

S. Draper, G. T. Houlby, M. L. G. Oldfield, A. G. L. Borthwick

Bridging the gap between biology (a rock) and physics (a hard place) for tidal energy research (BoA p. 67)

T. H. E. Smith, B. E. Scott

European Marine Energy Centre: the development of a targeted environmental monitoring strategy and the streamlining of marine renewables consents in Scotland (BoA p. 67)

J. Norris

V-D. Device hydrodynamics and structural mechanics 4 (continued)

Parametric Evaluation of the Performance Characteristics of Tightly Moored Wave Energy Converters for Several Floaters' Geometries (BoA p. 42)

S. A. Mavrakos, G. M. Katsounis

Comparison of damping properties for three different mooring arrangements (BoA p. 43)

A. W. Vickers, L. Johanning

Modelling the movement and wave impact of a floating object using SPH (BoA p. 44)

J. Vandamme, Q. Zou, D. Reeve, Y. Zhang

VII-C. Device and environmental modelling 3 (continued)

Comparison of Wave Power Extraction by a Compact Array of Small Buoys and by a Large Buoy (BoA p. 60)

X. Garraud, C. C. Mei

Transformation of Wave Spectra across a Line of Wave Devices (BoA p. 61)

A. Alexandre, T. Stallard, P. K. Stansby

Experimental Measurements of Irregular Wave Interaction Factors in Closely Spaced Arrays (BoA p. 61)

S. Weller, T. Stallard, P. K. Stansby

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Wave energy potential

Wave energy is a truly renewable, sustainable and literally priceless energy source. It will have a vast impact on electricity production in the world given that feasible solution in terms of technology, economy and ecology are provided.

Seabased has a robust, cost efficient and environmentally sustainable solution for wave energy generation. It is based on a revolutionary new generator and system design. A buoy on the ocean surface drives the unique wave energy converter that stands on the sea bed. Several wave energy converters are placed in a park together with switchgear and cable transmission from the park to the shore. This solution can be a significant complement to current electricity sources.

	P max	P average	Full Load (hours)
Sun	1 kW/m ²	100 W/m ²	1,000 h
Wind (11m/s)	1 kW/m ²	1 kW/m ²	2,200 h
Wave	20 kW/m	5-10 kW/m	3,000-4,000 h
	200 kW/m Norway	20-80 kW/m	4,000-5,000 h
Underwater current (2m/s)	4 kW/m ²	4 kW/m ²	7,000 h

Basic physics suggest that wave and underwater energy are extremely useful as energy sources. [P max = maximum power; P average = average power over time; Full load = hours of utilization corresponding to full power per year (8,760 h).]

Seabased Group

SEABASED AB • SEABASED INDUSTRY AB • SEABASED ENERGY BRITISH AB • SEABASED ENERGY USA AB

Seabased Group, with the mother company Seabased AB develops and implements industrial solutions for sustainable conversion of ocean wave energy to electricity, thereby creating lasting value for consumers, customers, society and shareholders.