ATLANTIS
RESOURCES

For more than a decade, Atlantis has pioneered the development of tidal current power as a predictable source of reliable, economic and secure renewable energy.

NOVEMBER 2014 **NEWSLETTER**

A NOTE FROM THE CEO

Timothy Cornelius

It has been a very busy year for the Atlantis group of companies, culminating in signing of a £51 million funding package for Phase 1A of the MeyGen tidal power project and entry into the seabed lease with The Crown Estate, the award of a £7.5 million contract from the Energy Technologies Institute (ETI) to deliver Phase 2 of the Tidal Energy Converter (TEC) programme, and the execution of a sublease agreement at the Fundy Ocean Research Centre for Energy (FORCE) in Canada, where offshore power export cables have now been installed.

There is a real energy energy around the company at present as we prepare for construction to get underway at MeyGen, marking a very significant event in the history of the tidal power sector. This project, which we believe to be the largest planned tidal stream development ever, is scheduled to start producing energy in 2016, paving the way for other projects around the world to follow our lead.

We are very proud of the achievements of our team, and we believe that it is important that we actively communicate our progress to our stakeholders as we reach each of the key project milestones between now and first power in 2016.

We are continuing to make solid progress on the design and delivery of the Atlantis AR1500 tidal turbine system with our technology partner Lockheed Martin. The final detailed engineering of the turbine design is due to be completed in Q1 2015. MeyGen entered into turbine supply agreements with Atlantis and Andritz Hydro Hammerfest (AHH) in August 2014, and this has enabled both suppliers to progress with procurement of long lead items. I am also delighted to report that the turbine technical teams have been collaborating well together to look for opportunities to exploit common connection and installation technology.

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PRE-CONSTRUCTION STAGE PROJECTS

CANADA

In October 2014 Atlantis secured its berth at the FORCE facility in Nova Scotia's Bay of Fundy. This berth allows Atlantis, working with our technology partner Lockheed Martin, to deploy a single grid-connected AR1500 turbine, which we see as a forerunner to larger scale development in this high resource area. Subsea cables for the project are already being laid by FORCE, and we are now planning the necessary permitting and survey work.

ETI PHASE 2

Atlantis, with the support of stakeholders and specialists from across the sector, successfully completed Phase 1 of the ETI's industry leading research and development programme in 2013/14, and has subsequently been awarded a £7.5 million contract for the detailed engineering, construction and demonstration of the innovations identified in Phase 1 as offering opportunities for step change reductions in the cost of energy. The central innovation is a new foundation concept which supports two turbines; we expect those turbines to be our AR1500 model, the design of which is consistent with the recommended architecture from Phase 1 of the TEC project. We have already engaged specialist subcontractors and are progressing well with the detailed engineering phase.

CHINA

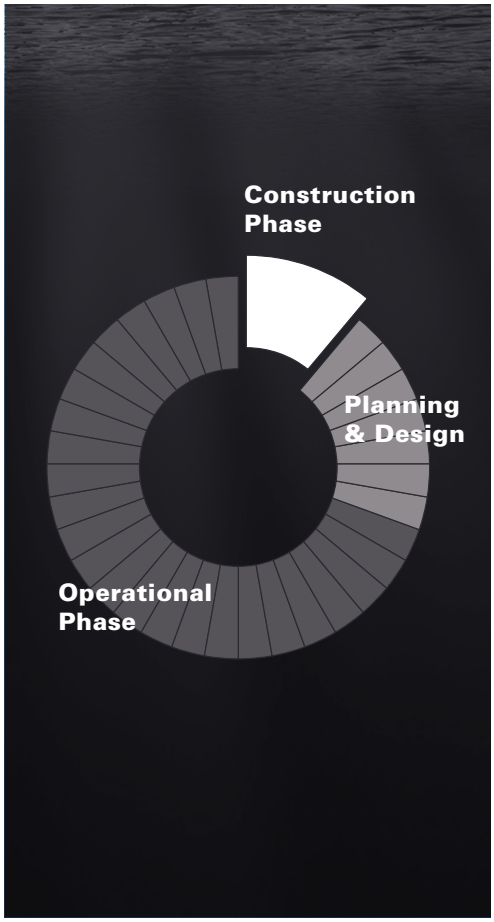
Work continues to support our client, the China Energy Conservation and Environmental Protection Group, with the process of securing the necessary permits for the first MW-scale tidal turbine deployment in China. The proposed site, in the small archipelago to the east of Shanghai, has a water depth of forty metres and flows similar to the north of Scotland. A successful turbine deployment there will open the way to turbine array projects in China, which offers good resource and a high energy demand.

MEYGEN
THE TIDE OF CHANGE IN CAITHNESS

NAVIGATOR AWARD

At the recent International Conference on Ocean Energy in Halifax, Nova Scotia, MeyGen was awarded the prestigious Navigator Award for making the most significant advance in the marine energy sector. The team is delighted with this accolade as it was presented by industry peers and stakeholders alike.

ICOE 2014
INTERNATIONAL CONFERENCE ON OCEAN ENERGY



MEYGEN PROJECT UPDATE

COMMENCEMENT OF CONSTRUCTION PHASE

After more than seven years of planning and design, we're now entering the construction phase for the first 6MW tranche of capacity in what we believe to be the world's larges planned tidal stream project. Now that the financing package has been agreed for the first four turbines, we've entered into all the major construction contracts. A team at ABB is making solid progress and will soon finish the design work relating to the onshore control centre at the Ness of Quoys in Caithness, construction of which is due for completion in September 2015.

Underground installation of the cable to the power distribution network, approximately 12 miles from our site, will commence in spring next year and will take a couple of months to complete. This work will be carried out by Scottish Hydro Electric Power Distribution, the network operator, and will enable us to export our clean energy to the grid and onwards to consumers.

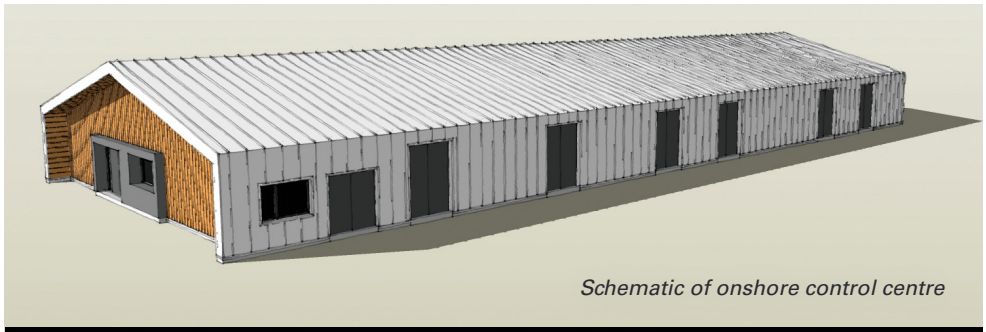
Our cable supplier, JDR, has received our order for the subsea export cables which connect the turbines to the onshore control centre. The cables will be manufactured at JDR's plant in Hartlepool in the north of England, and we expect the cable to be ready for delivery and installation in summer next year. These quadruple armoured cables,

totalling some 11.5km in length, will be laid along the seabed and brought to the onshore control centre though conduits drilled in the rock.

Our foundation suppliers will soon place orders for the 5,500 tonnes of steel required to fabricate the foundations and ballast blocks for all of the turbines. These will be fabricated at Nigg, in the Cromarty Firth, and Thurso, close to the project site, and are due to be completed next summer. These foundations rely on gravity to hold them to the seabed, and will remain in place throughout the life of the project. Specially designed connection systems allow the turbines to be installed and retrieved separately so that maintenance can be carried out.

MeyGen's turbine suppliers, AHH and Atlantis, are also progressing well. We have received confirmation from AHH that it has placed orders for the generators and gearboxes, which are to be assembled in Andritz's factory in Ravensburg, Germany and subsequently delivered to Scrabster harbour in 2016.

Cable reels being loaded at JDR's facility


Schematic of onshore control centre

A BRIEF INTERVIEW WITH MEYGEN CEO DAN PEARSON


MeyGen CEO Dan Pearson

Q: How many years have you been with the project and how does it feel for the project to finally enter the construction phase after so much planning, preparation and design?

I was introduced to the project back in April 2008 when I was hired as Atlantis' Project Director. My role was to work with the business development team and take the project through The Crown Estate's leasing round. Fast forward to today, and it is a great achievement that, despite the numerous challenges we have witnessed, the construction phase of this remarkable project is finally underway.

As for my feelings, I'm very proud of the team, many of whom have been with the project from the start, and I'm delighted for our shareholders, funders and stakeholders who have stood by us throughout. Everyone has had their part to play and we wouldn't be here without their efforts. Our focus has obviously now turned to the successful, on budget, and on time delivery of the construction and commissioning phase.

Q: How is the project team building in Edinburgh and have you been able to attract quality candidates to fill key project delivery roles?

This is an exhilarating sector to be in, and accordingly attracts some great candidates. Back in July we moved the London project delivery team to our new Edinburgh office, and began planning to build up the team for the delivery

phase. Within a week of reaching agreement on the financing we started an all-out campaign to seek candidates to fill a further six roles, and a significant number of CVs have been received and assessed which allowed us to progress to interviews with a number of suitable candidates for each role. At the time of writing this article, three of the positions have been filled and we expect the remaining roles to be filled over the coming months. I am sure that the added contribution that our new colleagues will bring to the project and Atlantis as a whole will be significant. I am excited by our prospects.

Q: When can we expect to see the first bulldozers on site at MeyGen and what will they be doing?

Onshore works will commence up in Caithness at the start of next year. The first stage of the works will be the construction of a 400 metre road, which will allow further plant and machinery to be brought up to the foreshore to start the drilling of the cable conduits and construction of the control centre.

Q: What percentage of the project supply chain is 'British'?

Approximately 50% of our spend is in Britain, and we have really sought to support the local supply chain as we recognise the importance of developing a strong industry here in the UK where tidal resource is so plentiful.

Q: What are the next series of project highlights we should look out for over the next three months?

- Completion of turbine foundation design and ordering of material for steel fabrication
- Offshore cable material order and commencement of cable manufacture
- Completion of the detailed design for the onshore control centre and commencement of road construction and civil works at the site

AR1500 turbine on gravity foundation

AR1500, ATLANTIS AND LOCKHEED MARTIN

PROGRESS ON THE AR1500 TURBINE DESIGN AND DELIVERY PROGRAMME

The AR1500 is a 1.5MW turbine rated at a water speed of 3 metres per second, or approximately 6 knots. A 1.5MW turbine at 40% capacity factor and 95% availability would generate around 5 million kWh of energy annually; in a year UK homes consume, on average, 4170kWh, so each AR1500 turbine would be capable of powering around 1,200 homes.

We believe that the AR1500 will be one of the most advanced tidal turbine systems ever developed, but advanced doesn't mean complicated – we're aiming to have fewer active components contained in the subsea nacelle than in our previous turbines, and this should lead to better reliability.

Earlier in the year, Atlantis formally commenced a contract with Lockheed Martin, the US engineering giant, to complete the detailed design and systems integration of the AR1500 tidal turbine. This design is driven by the tough operational and performance requirements of the MeyGen site, and builds on the pioneering work conducted by the Atlantis turbine design team over the past 10 years. Lockheed, with whom we have a teaming agreement for collaboration in tidal energy, was contracted to fulfil the role of overall systems integrator for the design, given an unparalleled track record of designing, building and operating complex machinery in some of the most hostile and remote environments on the planet. Lockheed is also, under the teaming agreement, working on the design and supply of a yaw drive system, which allows the turbine to rotate and face the incoming tide, and a variable pitch system, which enables the control system to adjust the angle of attack of the rotor blades.

AR1500 turbine with cutaway showing drive shaft, gearbox and generator

The AR1500 design programme is headed by Jeremy Thake, who has over 16 years of experience in the design and building of turbine systems with suppliers such as Marine Current Turbines (now a Siemens company) and Tidal Generation Limited (now owned by Alstom). Jeremy has strong technical expertise in tidal energy technology, from site surveys and resource modelling to detailed design of all areas of prototypes. He has commercial and staff management experience in both an R&D and a consulting context, and extensive practical experience in the manufacture, installation and operation of tidal turbines. He has managed international projects with multiple partners and funding agencies, and has a long background in product design and development.

Jeremy leads an 11 person team made up of domain experts in the fields of mechanical engineering, power electronics, control systems, hydrodynamics, flow modelling, blade design and structural engineering. The team is a multinational one, composed of experienced individuals recognised as thought leaders in their respective fields. Atlantis has always looked at tidal generation as a complete system, and our focus is on holistic solutions that take account of the foundation design, offshore connection management systems, onshore power conditioning and conversion equipment, system deployment and operations and maintenance considerations. Understanding these interface requirements helps drive down the cost of energy for the project developer.

The AR1500 has been designed with the intent of maximising reliability through simplicity, and uses drive train components that are passively cooled by the seawater surrounding the nacelle, making the turbine more compact and less prone to auxiliary system failures. The turbine will use the combination of a 2-stage gearbox with a medium-speed permanent magnetic generator to deliver the optimal blend of cost, reliability and efficiency across the entire tidal flow velocity range. We have also integrated the generator with the gearbox, so there are no separate generator bearings, again reducing the opportunities for failure. The overall aim is to maximise the yield of the turbine while making it as reliable as possible, and thus achieve a lower cost of energy.

The AR1500 has been designed with offshore operational constraints and future maintenance requirements in mind. Our experience in offshore turbine deployments at the European Marine Energy Centre (EMEC) in the Orkney Islands has allowed us to design and develop next generation procedures and smart tooling that improve safety and reduce or remove the need for divers and remotely controlled submersibles.

The AR1500 turbine delivery programme is led by Dave Rigg. Dave has been with Atlantis since 2009 and has accumulated a wealth of practical knowledge in the manufacture and deployment of tidal turbines and associated subsea connection infrastructure. This background is important in supporting completion of final turbine detailed design, ensuring that the design is undertaken in the context of the operational and interface considerations, and is compatible with the quality, time and budget demands of the turbine delivery programme.


The AR1500 design programme is headed by Jeremy Thake

INTERVIEW WITH OUR HEAD OF ENGINEERING AT ATLANTIS, JEREMY THAKE

Q: Please tell us why you believe that the AR1500 will be one of the leading turbines on the market once commissioned.

I have worked on many tidal turbine design and testing programmes for many years, and I have been fortunate to have worked in the industry from its inception with some of the best minds and brightest engineers in the field. The AR1500 is the culmination of all of the lessons learned during my time at various turbine suppliers, but if I had to select ten key features of the AR1500 system, they would be as follows:

1. Our choice of a medium speed 1.5MW permanent magnet generator will provide the optimal balance of performance, cost and reliability. Our drive train, which integrates the generator with a two stage gearbox, provides the best blend of cost and efficiency across the entire tidal range, from peak to trough. Our gearbox has been designed by Involution in the UK, and will be integrated with a generator from The Switch which will be manufactured in Finland during winter 2014/2015

2. The AR1500 embraces modular design which not only affords flexibility in supply chain solutions, but importantly provides rigorous quality control assurance at the pre module-assembly level, and reduces integration complexity into the final product. The modular solution has been designed to provide cost and time effective transformation into the assembled turbine, aiding both delivery quality control and through-life planned maintenance events. The approach also assists more nimble supply logistics

3. The AR1500 has been designed to an extensive list of load cases in line with DNV-GL guidelines produced from an industry validated software package covering the complete set of operational and extreme conditions

4. At Atlantis, we are dedicated to safety and to sustaining our internal target of zero environmental harm during deployment and operation of our machines, and that is why we are pioneering the design and use of a nacelle installation tool that will allow the turbine to be guided onto the pre-installed foundation without the intervention of divers and submersibles. We hope this approach will become the standard across the turbine market. Once in position, our diver and submersible free connection management system will facilitate connection of the turbine whilst the installation vessel is still on station in under 60 minutes

5. Passive seawater cooling takes advantage of the cooling capability of the ocean whilst increasing reliability through reducing active components. Simply put, the fewer parts you have underwater, the lower the probability that things can go wrong. The KISS principle rings true in the tidal power market and passive cooling means we use the ambient temperature of the seawater surrounding our turbines to cool the generator, gearbox and all essential components

6. The blade pitching system gives us greater control of the turbine, for better energy extraction, and allows the blades to be adjusted to reduce the load in extreme conditions. Lockheed Martin is developing the pitch system for the AR1500

7. The AR1500 will have a 360˚continuous yaw drive system designed by Lockheed Martin. This rotates the nacelle and orientates the blades into the direction of the prevailing water flow, which reverses between flood and ebb tides. It also allows us to line up with any changes in the direction of tides that occur during the seasons. We only yaw the turbine at slack water, which simplifies the yaw mechanism and increases its life; tidal flow tends to stay roughly in the same direction during a tide, so there is no need to move when the turbine is operating

8. The AR1500 will be fitted with an on-board electrical system designed with reliability in mind. This turbine will be operating in harsh environments around the world, and whilst we don't expect there to be system failures, much like planning a space mission, we must ensure that there is redundancy in all core systems. The AR1500 on-board electrical system, which has been designed in house, offers a minimum two-times redundancy in order to help us to achieve the extended service free periods our clients demand (up to five years without a planned retrieval)

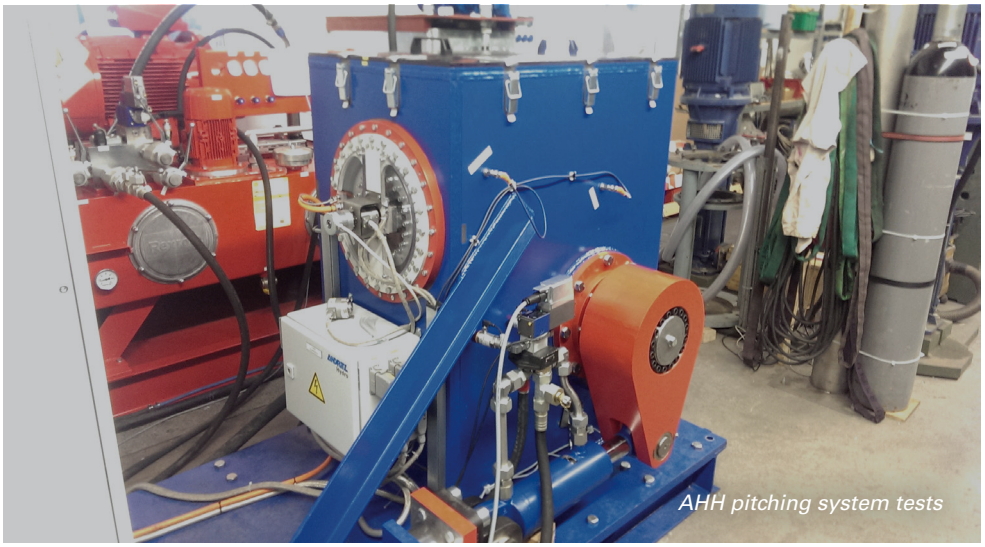
9. The AR1500 will use glass reinforced plastic (GRP) blades designed for survivability as well as ease of connection and disconnection from the nacelle hub. In the very early days of tidal power, rotor blades were a point of potential weakness for tidal turbine systems. The last 10 years of industry wide testing and deployment has proven that a well-designed composite blade can not only withstand the forces that will be seen on the MeyGen project site, but can also achieve efficiencies in excess of 45%. Atlantis is using a pioneering design of blade material proven on the AR1000 that relies on its GRP shape rather than a carbon fibre spar for its strength; this will result in cheaper, more easily manufactured units. Each blade will undergo a rigorous testing programme before deployment using our DNV-validated blade test unit

10. Proven sealing systems backed by an extensive water management system (WMS) for further risk mitigation. Where possible, components selected for use on the AR1500 must have a proven track record of performance in the harshest of environments for a sustained period of time, and our sealing systems are provided by world renowned IHC in the Netherlands. IHC has been the seal supplier of choice to ship yards and ship builders for more than a decade and our proprietary WMS means that in the unlikely event we have a leak, we can bilge water from the oil compensation systems to eliminate the need for nacelle recovery.

HS1000, ANDRITZ HYDRO HAMMERFEST

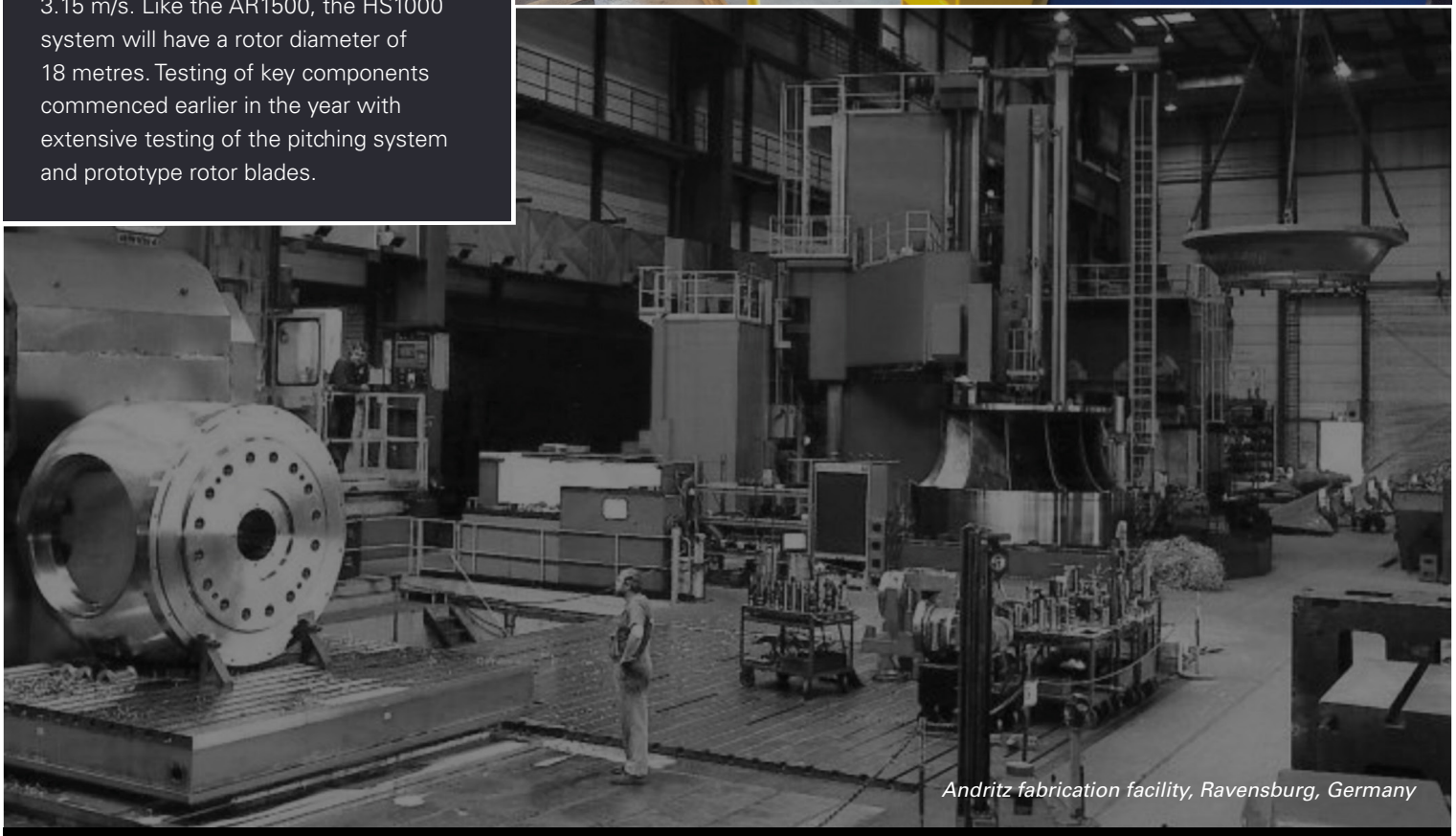
The AHH turbine delivery programme got underway in September this year following entry into a turbine supply agreement with MeyGen for three 1.5MW systems. The 1.5MW AHH systems, which will be manufactured at the Andritz plant in Ravensberg, Germany, build on the success of the 1MW version of the HS1000, which has been tested at EMEC over the past two years. AHH has placed its orders for long lead items, and is due to complete construction of the first turbine in early 2016. The remaining two turbines will be delivered after completion of the installation and subsea commissioning of the first unit, thus allowing AHH to implement any modifications identified during commissioning.

Unlike the AR1500, the HS1000 will use an induction generator capable of generating 1.5MW in water flows of 3.15 m/s. Like the AR1500, the HS1000 system will have a rotor diameter of 18 metres. Testing of key components commenced earlier in the year with extensive testing of the pitching system and prototype rotor blades.



AHH pitching system tests

AHH prototype rotor blade



Andritz fabrication facility, Ravensburg, Germany