SeaGen-S 2MW

Proven and commercially viable tidal energy generation
The SeaGen Advantage

The generation of electricity from tidal flows requires robust, proven, available, and cost-effective technology. SeaGen-S 2MW is the most advanced, field proven tidal generation system available. As the pioneer and first mover in tidal the energy sector, MCT have developed and patented key features, that deliver commercially viable electricity generation.

These system features have been field-proven since installation in 2008, of the commercial scale, SeaGen-S 1.2 MW grid connected system. By 2012, SeaGen-S had delivered ten times the amount of electricity to the grid than all other tidal devices combined.

Following MCT’s acquisition by Siemens, SeaGen-S 2MW is being developed and tested to the highest production standards, benefitting from Siemens world class, delivery of renewable energy technology to global utilities. SeaGen-S 2MW is designed around the principles of; Cost-Effectiveness, Availability, Proven Engineering and Environmental Responsibility.

Cost-Effectiveness
Each SeaGen-S 2MW device consists of twin 1MW powertrains, delivering 2MW of grid conditioned electricity to the substation. This configuration reduces the cost per MW by minimising cabling and associated distribution infrastructure. The pitch-controlled blades and high efficiency powertrains, extract the maximum energy from the available tidal resource.

Availability
Building upon 1000’s of generating hours from SeaGen-S 1.2MW, SeaGen-S 2MW has matured its engineering for greater reliability. With its unique raising mechanism allowing low cost and rapid access to the powertrains, and power conditioning and control systems in its tower, SeaGen-S provides unparalleled maintainability and unbeatable availability.

Proven Engineering
With 3GWh generated by 2012 and the system continuing in 24-7 operation, SeaGen-S has proven its’ engineering way beyond any competing device. Not only is the concept fully demonstrated, but the detailed engineering design including longer-term fatigue characteristics are now proven.

Environmental
In addition to producing zero-carbon electricity, MCT is committed to ensuring minimal impact on the environment from installation and operation in sensitive coastal waters. An independent environmental monitoring programme was commissioned to study the installation and first three years of operation of SeaGen 1.2 MW. In 2012 the studies concluded that, with the mitigation in place, there had been “no significant environmental impact”.

The SeaGen Advantage
**Technical Description**

**Seagen-S 2MW**
The Seagen S 2MW tidal generation system evolves the highly successful 1.2MW Seagen S device that has been operational in Strangford Lough since 2008. With the insight and experience gained from this project, MCT has been able to optimise the system design to deliver 2MW with greater availability and at lower cost.

**Rotor**
The Seagen S tidal turbine incorporates twin horizontal axis rotors. The rotors utilise an active blade pitch system which limit structural forces during high flow conditions. This allows the use of blades that are highly efficient over the full range of tidal velocities, from initial cut-in through to rated flow. Energy capture is further enhanced by variable speed operation which allows the turbine to operate at its optimum tip speed ratio (all the way up to up to rated power) whilst supplying grid compatible electrical power at a frequency and voltage to match the local distribution network. The power conversion system is a modular arrangement for easy maintenance.

**Blade pitch system**
The blade pitch arrangement is used to optimize and regulate power output throughout the operating range. The blades can be feathered to minimize hydrodynamic loads during extreme wave or tidal conditions.

**Main shaft and bearing**
The main shaft is forged in alloy steel and is hollow for the transfer of power and signals to the blade pitching system via slip rings.

**Gearbox**
The efficient and lightweight planetary gearbox allows a very compact and light power train to be realised. This simplifies maintenance operations and support logistics as well as reducing overall structural weight and cost.

**Power conversion**
The power conversion system allows the rotor to operate at optimal speed over the range of tidal velocities (from initial cut-in to rated power) whilst supplying grid compatible electrical power at a frequency and voltage to match the local distribution network. The power conversion system is a modular arrangement for easy maintenance.

**Controller**
The controller is compatible with turbine safety requirements, is self-diagnosing and includes a keyboard and display for easy status readout and adjustment of settings. The system allows; remote interrogation, the reset of turbine alarms and provides comprehensive data logging functionality.

**Mechanical brake**
The system incorporates a hydraulically realised brake which serves as a parking brake for crossbeam lifting and maintenance operations, and is also used to ensure safe shut-down under some theoretical fault conditions.

**Remote control**
The tidal turbine is equipped with a web based SCADA system. This system offers; remote control, a variety of status views and useful reports from a standard internet web browser. The status views present; electrical, mechanical, meteorological and tidal data, as well as operation, fault and grid status.

**Support Structure**
The twin 1MW tidal drive trains are mounted at each end of a crossbeam which in turn is supported by a surface piercing tubular steel tower. The cross beam can be raised, as required above the sea surface to maintain the drive trains, avoiding the cost and delay associated with expensive marine vessels. MCT can provide support to array developers to design foundations to meet local site conditions.

**Mechanical brake**
The system incorporates a hydraulically realised brake which serves as a parking brake for crossbeam lifting and maintenance operations, and is also used to ensure safe shut-down under some theoretical fault conditions.

**Controller**
The turbine utilises a standard wind turbine control system provided by a leading supplier. The controller is compatible with turbine safety requirements, is self-diagnosing and includes a keyboard and display for easy status readout and adjustment of settings. The system allows; remote interrogation, the reset of turbine alarms and provides comprehensive data logging functionality.

**Turbine Condition Monitoring**
In addition to the Web SCADA system, the turbine is equipped with a web-based Turbine Condition Monitoring (TCM) system. The TCM system carries out precise, continuous, real time, condition diagnostics on main turbine components. The TCM system has various alarm levels, from informative through alerting level to turbine shutdown.

**Grid compliance**
The Seagen S system complies with current grid code requirements and due to the use of modern frequency converters, can be adapted to meet emerging standards and network requirements associated with tidal arrays.
## Specifications

### Rotor
- Diameter: 20 m
- Swept area: 628 m² for 2 rotors
- Rotor speed: 4 – 11.5 rpm
- Power regulation: Active blade pitch regulation

### Transmission System
- Gearbox type: Planetary
- Gearbox cooling: Direct to passing sea water

### Mechanical brake
- Type: Hydraulically released

### Generator
- Type: Asynchronous
- Nominal power: rated to provide 1,000 kW into grid
- Voltage: 690 V
- Cooling system: direct to passing sea water

### Monitoring system
- SCADA system: Web based
- Remote control: Full turbine control

### Tower
- Type: Cylindrical tubular steel
- Hub height: Tailored for water depth/navigation constraint issues

### Operational data
- Cut-in tidal speed: 1 m/s
- Rated power at: 2.5 m/s

### Weights
- Drive trains: 60 tons
- Tower: Site-specific

### Power Curve for SeaGen - S 2MW

![Power Curve Graph]

- **Power kW**
  - 0
  - 500
  - 1000
  - 1500
  - 2000
  - 2500
- **Velocity m/s**
  - 0
  - 0.5
  - 1
  - 1.5
  - 2
  - 2.5
  - 3
  - 3.5
  - 4

### Tower
- Incorporating power conditioning and control systems

### Crossbeam
- Can be raised for access to the power trains

### Foundation
- Export cable for grid-ready electricity

### Powertrain
- 1 MW
The information in this document contains general descriptions of the technical options available, which may not apply in all cases. The required technical options should therefore be specified in the contract.

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