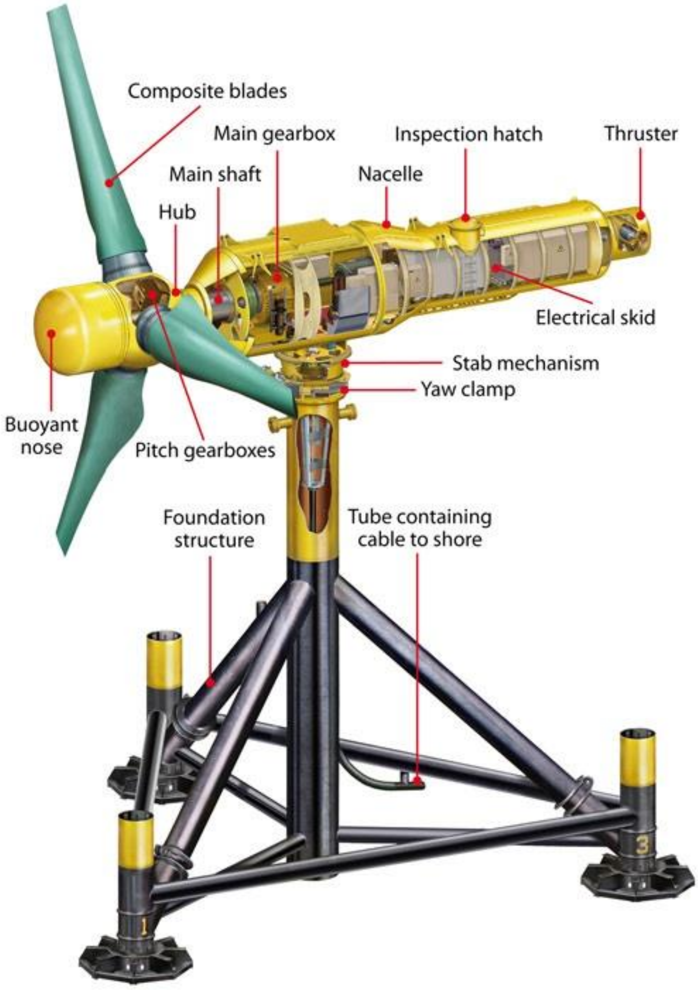
Tidal Stream Generator

Defining characteristics	Narrative
General	Tidal streams are water currents associated with the periodic piling up and ebb of water masses in oceans, coastal seas and estuaries driven by gravitational interaction between the Earth and the Moon. Tidal streams are thus characterised by continuous changes in speed and direction, and are usually stronger nearer to the coast. Historically, the global oil crisis in the 1970s and global environmental and energy policies in subsequent decades are two of the key driving forces behind invigorated interest in tidal energy resources, whose viability was first demonstrated by the commissioning of the Rance tidal power station in 1966.[77] Essentially, tidal stream power generation is a non-barrage approach to power generation that uses axial turbines, oscillating hydrofoils, Archimedes screws, and Venturi devices to extract energy from the mass of moving water. Axial turbines, the most commonly deployed tidal stream generators (TSGs) technology harvest kinetic energy of water mass in much the same way as a wind turbine does from windstreams. Prototype and commercial TSG installations can be found in the UK, Norway and US (Hammons, 2011; Khan et al., 2009; Meisen and Loiseau, 2009; Bahaj and Myers, 2003).
Siting and land use	Selecting an appropriate location for TSGs is one of the most important aspects of filed deployment of the technology. Siting is ordinarily preceded by extensive field surveys and informed by knowledge of areas with fast currents. Other key considerations include existing uses, alternative uses, accessibility, bathymetry and geology of potential sites. Some TSGs can even be attached to existing infrastructure such as bridges if these are optimally located from an energy production perspective. In all instances, permits must be obtained prior to deployment, with impacts on navigation, fishing and marine life being three critical decision factors. The size of a tidal farm, that is, the area required for installation of large numbers of TSGs, ultimately depends on the tidal energy potential of the site, and rated capacity of turbines.
Design (components) and Operation	Horizontal axis flow TSGs are made up basically of four basic parts: 1) a mooring system, 2) rotor, 3) gearbox, and 4) an electrical generator. A low speed shaft connected to rotor, gearbox and electrical generator r are housed inside a water-tight nacelle that connects to a power transmission cable. Some TSG designs include a yaw mechanism that rotates the nacelle into the tidal current thus augmenting efficiency of the TSG. In some other designs, rotors' direction of rotation reverses with in reaction to a reversal of the direction of tidal streams whilst the nacelle remains stationary (Meisen and Loiseau, 2009; Bahaj and Myers, 2003) Variable pitch rotor blades, two or three in number, 6 to 25 meters in diameter, partially harvests the kinetic energy as water flows through their sweep area. The angular velocity of rotating blades is increased several-fold in a gearbox that connects to an alternator generating an alternating current based on the principle of electromagnetic induction.[78] Generated electricity[79] is delivered to a collection system on sea floor supplies power via a submarine cable to an on-shore sub-station where the voltage is stepped up before it is sent into the grid. TSGs are stably maintained the mass of flowing water on structural support elements that form the basis of a mooring system. The less common surface-based mooring systems consist primarily of a rigid support shaft protruding from a pontoon into the water below. Sea floor mooring systems include sunken piles, concrete blocks and tripod trusses. Crucially a turbine and mooring system have to resist axial thrust to avoid catastrophic dislocation (Khan et al., 2009; Bahaj and Myers, 2003). Piles usually

[77] On the estuary of the Rance River in Brittany, France
[78] Faraday's law of electromagnetic induction
[79] In the range of 300 to 1200 kW per turbine currently

	rise above the water surface, and in some configurations can accommodate multiple turbines. For cost-effective and efficient power production, an array of TSGs may be needed and this also calls for careful design in order to curtail efficiency losses due to wake effects generated by individual devices. A single row of TSGs is likely to be the most efficient configuration; good location decisions hold the key to efficient energy capture.
Costs	As with most renewable energy technologies, location-specific energy density of the energy resources has a big impact on unit costs of energy production. In the UK, reputed to have some of the world's most promising tidal stream sites, capital cost of electricity generation from TSG deployment is estimated to lie between GBP1429/kW and GBP1,736/kW (Hammons, 2011). Elsewhere in the US, capital cost is estimated at USD5,880/kW, with corresponding fixed operation and maintenance (O&M) cost of USD198/kW.yr (Black and Veatch, 2012).
Supporting infrastructure	Transformer Control room Service vessel A facility for raising the turbine unit
Advantages	Can typically produce four times the energy generated per rotor sweep as an equally power-rated wind turbine (Meisen and Loiseau, 2009). High load factors and predictable resource characteristics (Bahaj and Myers, 2003) Little environmental impact
Disadvantages /Challenges	Technology still undergoing development (Khan et al., 2009 Costly installation and maintenance (Black and Veatch, 2012) Hazards to large sea mammals, navigation and shipping Risks of fouling from growth of marine organisms on the blades and mechanism (increasing drag and hence reducing performance)
Abatement potential	CO_2 emissions abatement as a consequence of tidal stream turbine deployment depends not only on the fuel mix powering the grid, but also on the performance characteristics of turbine technology variants and their operating environment. In analogy to wind turbines, tidal stream turbines could reduce emissions by 434 to 975 gCO_2 per kWh of electricity produced from natural gas and coal-fired turbines respectively.
Level of penetration	TSG is an emerging technology, completely new to the Gambia



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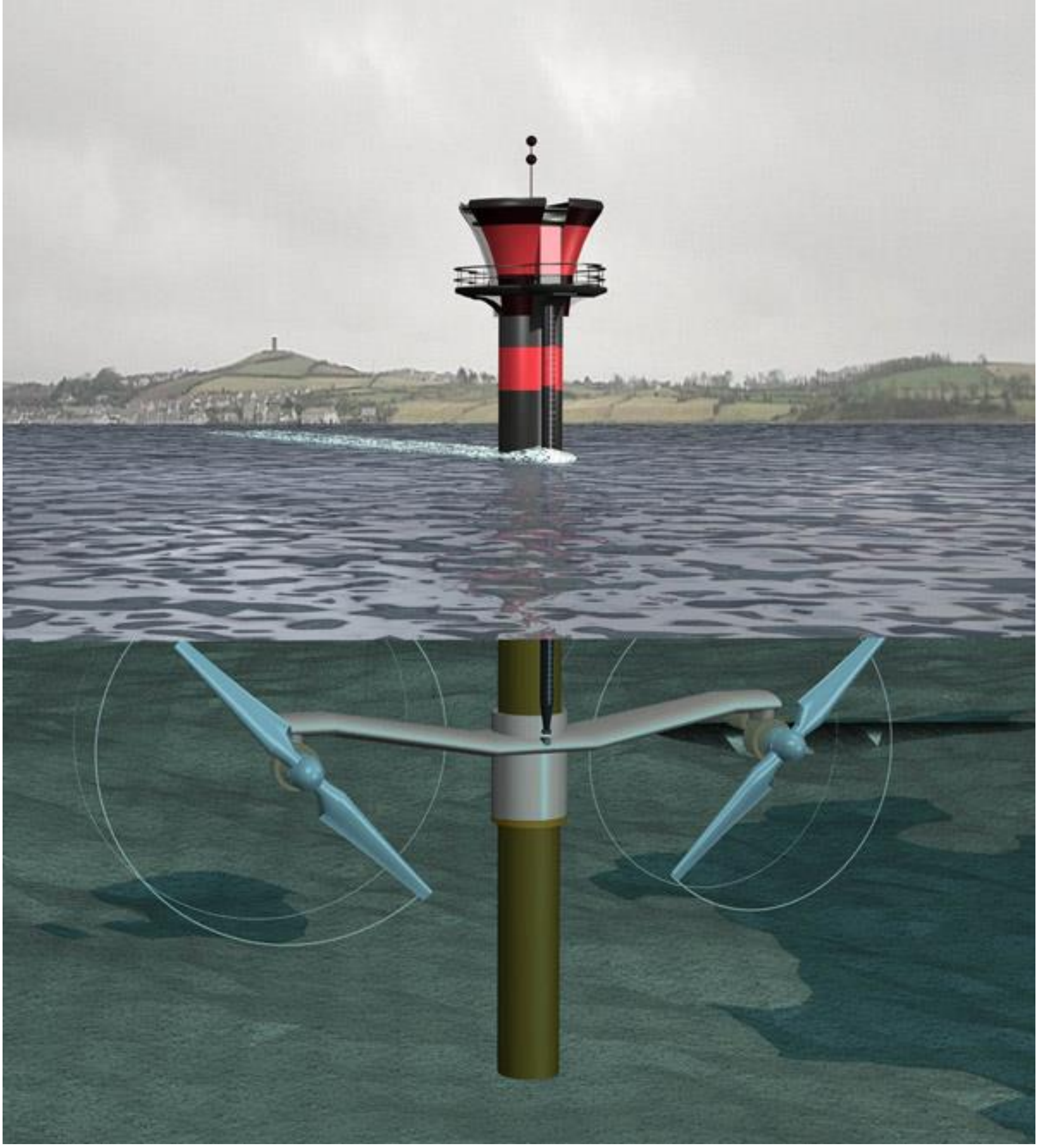

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Further readings

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