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Research & Technical Abstracts / Workshops

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Unidirectional Rotation Rotor for Tidal Stream and Wind Power Generation

Authors:
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Tidewind Inc. is a power generation technology company that develops innovative power turbines for generating electricity by harvesting energy from two very different natural renewable sources – marine tidal streams and wind.

Tidewind Inc. has developed a new type of rotor (US and PTC patent pending) that can be used as a major part of a marine tidal stream turbine or power generation system, where seawater flows in opposite directions during flood or ebb currents. These UDRR-based turbines can be manufactured with different output capacities depending on installation location, customer requirements, and budget restrictions. Those turbines can be installed on the seabed or floating platforms and generate electricity in low to medium speed tidal streams. UDRR-based turbines can also be used for hydro generation in single-direction flows of water, such as hydro power station spillway water streams, river streams, etc.

This unidirectional rotation rotor (UDRR) was invented by Mr. Dmitriy Minenko, B.Sc., Founder and CEO of Tidewind Inc., and this invention was aimed at achieving:

- simple design
- high reliability
- lower cost of manufacturing using additive manufacturing
- lower repair and maintenance costs during the service lifecycle
- low utilization cost at the end of the exploitation lifecycle
- design safe for the environment and any form of sea life, including any size of fish and sea mammals

Absence of yaw control system, blade pitch control system, and any gearboxes that are normally used in other hydro or wind power generation turbine types could simplify the manufacturing process and significantly reduce the cost of new UDRR-based turbines for tidal and wind power generation systems, which leads to lowering the initial investment cost of turbine deployment. It will also lead to higher reliability of the UDRR-based turbines and a significant reduction of related repair and maintenance expenses during the lifespan of these power-generating turbines.

SeaVortex : A Multi-Resource Marine Energy Platform For Waves, Currents and Tides

Authors:
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Ocean renewable energy has emerged as a critical resource in powering significant portions of global economies. However, commercial-scale solutions remain elusive due to technical challenges, high costs, and environmental concerns. This report introduces an innovative marine energy platform called **SeaVortex**, developed by Wave Water Watt Inc., aiming to address the limitations encountered in current ocean renewable energy systems. **SeaVortex** is designed as a multi-functional, modular platform capable of extracting kinetic energy from waves, currents, and tides. **SeaVortex** concept is evaluated within the IEA-OES framework, and initial performance analysis revealed LCOE values of 84.12 $/MWh for the tidal stream scenario at the Bay of Fundy, 109.46 $/MWh for wave energy at California coast, and a combined wave-current scenario in Florida coast yielding an LCOE of 96.79 $/MWh. These findings align with the IEA-OES 2050 vision, suggesting that **SeaVortex** holds significant promise as a versatile platform for ocean energy.

Novel Station-keeping for Redundancy and Dynamic Load Reduction at any Depth

Authors:
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Floating offshore structures for wind or wave energy must be restrained to prevent them from drifting too far from their desired position. This requirement is called stationkeeping. Historically, heavy chain has been used to provide inertial restraint in shallow waters. Chain becomes uneconomical or introduces difficult design constraints beyond moderate depths. In deeper waters, synthetic lines attached to seabed anchors are preferred. An emerging approach uses shared mooring elements, including anchors or lines which restrain multiple floating structures. While this offers cost advantages, it also introduces a risk of cascading failure. In addition, the design of mooring systems generally must balance tradeoffs between the quality of stationkeeping and the dynamic loads induced in mooring system elements, which may govern their design.

Arup, the global engineering consultancy, introduces a novel approach to stationkeeping for floating offshore structures which is applicable to wind, wave, and other installations. The approach, called Marine Ensemble Tension Stationkeeping (METS), significantly reduces dynamic loads on mooring elements and anchors and provides redundancy to prevent cascading failure in case of element loss. It reduces drift distances of floating structures and thereby limits the excess length required for electricity-carrying cables. It is suitable for shallow to deep waters and is adaptable to any geometric configuration. It uses shared anchors and synthetic mooring lines, minimizing the use of steel chain, impacts on the seabed, and the number of anchors required.

We will describe the novel stationkeeping system, its anticipated benefits, challenges, and next steps.

High-Fidelity Resource Modelling for Wind and Tidal Energy

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Through the use of computational fluid dynamics, numerical models of tidal turbines and offshore wind farms have now evolved to the stage where they can study prospective deployments from both engineering and environmental perspectives. Not only can such models examine in detail the performance of each turbine in an array of devices, they can inform estimates of reliability and environmental impact assessments too. These types of computer simulation get closer to a ground truth than has been possible previously.

This presentation will discuss work by the author and others in the development of CoastED and WATTES, software that has been used for tidal and wind farm simulations. It will detail their application to tidal turbines and tidal sites within the Bay of Fundy, and demonstrate how such modelling can be used to assess biological impacts to fish species and other marine fauna. Finally, it will address how these techniques can be cross-applied to wind farms - all while producing detailed engineering diagnostics critical for economic assessment.

Modelling Fish Trajectories through Minas Passage

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Tidal energy in the Minas Passage can only proceed if we can accurately predict the impact of tidal turbines on protected fish species, including Atlantic salmon and white shark. Previous work has provided invaluable field data from Minas Passage: satellite-tracks of surface drifters and telemetry data of tagged fish. The telemetry data has been used to calculate an encounter probability, but this estimate comes with a high level of uncertainty. In this work, we use mathematical models of the trajectories of fish through the passage to reduce this uncertainty.

We will present the results of two mathematical models. The first is a simple Lagrange particle tracking model that will be used to model drifters and passive fish. The model allows for the calculation of trajectories using different initial conditions, different phases of the tides, and different parametrizations of small-scale turbulence. We will present the results of the model calibrations/validation against the known trajectories of surface drifters. We will then present the results of simulating passive fish trajectories, comparing these to the telemetry data.

Assuming that fish are relatively passive may be reasonable for smaller fish in fast moving flows of Minas Passage but is certainly not reasonable for larger fish like the white shark. However, observing fish behaviour in fast flowing currents is very difficult. The second mathematical model will be an agent-based model, where the individual fish can respond to their environment by swimming. The approach facilitates not only more realistic simulation of the likelihood of a fish encountering a tidal turbine, but also how it might respond to the turbine. We will present the results of adding simple fish behaviour, for example the preference of salmon smolts to swim to the west and migrate out to the Atlantic Ocean, and determine which behaviour best agrees with telemetry data.

Towards the Design of a Tidal Turbine Hub Retrofit using a 2D CFD-based Optimization Approach

Authors:
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This work numerically investigates how a retrofitted hub geometry affects the power extraction of a Horizontal Axis Tidal Turbine (HATT) using RANS-based CFD simulations. At the root region of traditional HATTs, the blade transitions from a hydrofoil to a circular cross-section for structural and operational requirements. These constraints lead to a local low lift to drag ratio experienced by the blades. As a result, a root loss is incurred on the system, creating a reduction in turbine performance. This has been shown to reduce efficiency by approximately 5% for wind turbines using a systematic diagnostic study. Minimizing this loss is the primary motivation of adding a hub retrofit, as it is theorized to delay stall and convectively accelerate flow onto regions of the blades which contribute significantly to torque production. After performing a fully resolved 3D CFD-based parametric study that modified the radius and relative location of the retrofit geometry, a net improvement in power generation was not observed. However, the tangential force contribution of the main turbine blades was increased by a maximum of 2.94%. The current work attempts to improve upon this parametric study by employing an internally developed 2D CFD-based optimization strategy that maximizes lift to drag ratio for multi-element hydrofoils by varying relative position and orientation. It has been empirically concluded that the search spaces for relevant multi-element hydrofoil configurations are largely unimodal, allowing for non-population trajectory-based optimization algorithms to be applied. By implementing this workflow at strategically selected spanwise locations, the retrofit geometry can be reconstructed and simulated using the same process established in the parametric study to enhance net power generation. Given that 3D hydrodynamic phenomena are not considered within the outlined optimization strategy (e.g. spanwise flows, tip/root vortices), subsequent work will explore whether incorporating these effects into the retrofit design optimization is warranted.

Towards Reducing Fish-Turbine Collision Risk Uncertainty in the Bay of Fundy

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A key outcome of Canada's Task Force on the Sustainable Development of Tidal Energy in the Bay of Fundy was identification of the need for industry enabling activities that more accurately quantify the risks of fish-turbine encounters. Multi-pronged, multi-year, collaborative research programs to address collision risk uncertainty are being led by FORCE and Acadia University, in collaboration with the University of the Highlands and Islands, University of Edinburgh, the Ocean Tracking Network, and tidal energy developers. This includes the integrated and comprehensive use of optical and acoustic sensing technologies and novel sensor platforms, tracking of fish movements through Minas Passage for fish species of concern, and modelling and measuring forces acting on fish that pass through the FORCE tidal energy development site. The research underway has been designed to test the performance of marine life sensing technologies and sensor system applications, using both sea-surface and sub-sea sensor platforms. It also involves the tagging and tracking of six fish species of interest (Atlantic salmon, Atlantic sturgeon, Atlantic herring, American eel, striped bass, and alewife), using High Residency (HR) acoustic tags and HR receiver arrays, to inform predictive models of the probability of fish encountering the swept area. Collision risk assessments for different deployment scenarios (surface and bottom tidal stream devices) will be informed by multiple data sources, including from 'Sensor Fish' experiments, integrated optical cameras and acoustic sensors, tag transmission detections, drifter track trajectories, FVCOM outputs, and CFD models which include simulations conducted for different flow speeds and varying turbine designs and operating states. The results will serve to reduce collision risk uncertainties and inform best practices in environmental effects monitoring (fish-focused) and associated data analysis methods for monitoring plans of tidal developers.

Progressing Tidal Energy through Organized Data Approaches

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As the tidal energy industry reaches commercial status in parts of Europe and pre-commercial status in North America, more environmental data are being collected, and research studies continue to address the most difficult questions around risks to marine life and environment. Collision risk of fish and marine mammals, as well as diving seabirds and sea turtles, remain the most challenging tidal turbine interactions and the focus of extensive studies in many parts of the world. At the same time, questions around animal disturbance from acoustic output of turbine or electromagnetic fields from power export cables, as well as alterations of benthic and pelagic habitats need to be addressed to achieve regulatory permission to deploy and operate tidal farms. In addition, as marine energy projects scale up to large arrays, interactions like displacement of marine animals or entanglement in mooring lines will need to be investigated.

Working with 15 other nations, Ocean Energy Systems- Environmental (OES-E) has developed tools and frameworks to assist in organizing and applying data and information on potential risks from tidal turbines to permitting, mitigation, and licensing. Tools have been developed that organize data to match regulatory needs including risk retirement, data transferability, management measures, and guidance documents. This paper will discuss the application of these tools and frameworks.

Validating Environmental Monitoring Systems for Tidal Turbines

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Brian Sanderson, Acadia University
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Collision risk between marine animals (fish, diving seabirds, and marine mammals) and tidal turbine blades is often a significant barrier to consenting tidal stream energy projects. Data collection efforts are limited due to challenging operational environments, and a scarcity of validated sensors and automated processing algorithms. Floating tidal turbines present unique environmental monitoring challenges compared to seabed turbines, due to increased flow speeds, surface air entrainment, and the dynamic nature of their platforms. However, floating turbines enable opportunities for accelerating industry data collection through lower-cost sensor installation, ease of access for maintenance and more straightforward data export and power connectivity, but only if technical and engineering issues can be resolved. As the industry transitions from single turbines to large-scale arrays, robust monitoring systems to observe animal behaviour around these devices becomes even more essential.

Here we present research from the operational O2 floating tidal stream turbine at the European Marine Energy Centre (EMEC) in the UK, trialling multibeam imaging sonar for automated target detection alongside video data to aid target identification when visibility permits.

Sensor performance across operating conditions is being characterised, alongside development of algorithms for automated data processing utilising data collection from in situ field testing. The aim is to optimise the system for detecting and documenting marine animal interactions within the rotor-swept area.

The outcomes can be used to inform consent and operation of tidal stream turbines, including future deployments of the O2-X turbine targeting the Bay of Fundy through demonstrating the transferability of results and techniques, and are feeding into wider sensor trials being planned in Nova Scotia, Canada.

Stronger Relationships: Netukulimk, Etuaptmumk and the Future of Ocean Energy Workshop

Panelists:
Chief Sidney Peters, Glooscap First Nation; Co-Chair, ANSMC
Angeline Gillis, Executive Director, CMM
Patrick Butler, Senior Mi'kmaq Energy and Mines Advisor, KMK
Lindsay Bennett, Executive Director, Fundy Ocean Research Centre for Energy (FORCE)

Workshop Title:
Stronger Relationships: Netukulimk, Etuaptmumk and the Future of Ocean Energy

Workshop Description:
This workshop will explore how Mi'kmaq leadership, practices, values, and knowledge—particularly through the lens of Netukulimk (respectful resource use) and Etuaptmumk (Two-Eyed Seeing)—can be meaningfully integrated into marine renewable energy project planning, stewardship, and research. Drawing from lived experience and collaborative initiatives, including a recent Mi'kmaw Chiefs' delegation to Scotland to visit EMEC and Orbital Marine Power, the session will share practical insights on partnership building and respectful engagement. Discussion will include:

- How to approach and engage Mi'kmaw Chiefs and leadership in a way that reflects their roles as Rights Holders and knowledge keepers, not stakeholders.
- How research and monitoring can be shaped by Mi'kmaw perspectives.
- How projects can align with Indigenous laws, values, and environmental ethics.
- How to foster dialogue early and in ways that centre Mi'kmaw priorities, cultural protocols, and community timelines—rather than project-driven pressures.
- How to move beyond engagement toward true collaboration—without placing undue burdens on Mi'kmaw communities.

Three Objectives/Targeted Outcomes of the Workshop:
1. How to approach Mi'kmaw leadership practically, respectfully, and meaningfully.
2. How to integrate Etuaptmumk into research and monitoring design and activities.
3. How to meaningfully engage without placing undue burdens on Mi'kmaw communities.

Target Audience:
Anyone interested in equitable and inclusive approaches: Industry, Academia, MRE project developers, Government, Researchers.