“The VIVACE Converter: Enhancing Flow Induced Motions to Harness Hydrokinetic Energy in an Environmentally Compatible Way”

Michael M. Bernitsas, Ph.D.
University of Michigan
Dept. of Naval Architecture and Marine Engineering
Dept. of Mechanical Engineering

ABSTRACT: Marine hydrokinetic energy is abundant, clean, renewable, and worldwide available. The vast majority of ocean/river currents are slower than 2-3 knots while turbines require an average of 5-7kn to be financially viable. Can we harness such a treasure in an environmentally compatible way, i.e. without using dams/turbines, and convert it to affordable electricity?

Dr. Bernitsas will present the research and development of the VIVACE (Vortex Induced Vibrations for Aquatic Clean Energy) Converter, from concept to prototype testing in the St. Clair River, showing how fundamental developments in cylinder-hydrodynamics discovered in the Marine Renewable Energy Lab were implemented in design to achieve power densities about 15,000 times those of wind farms. The basic drive is to enhance flow-induced motions (VIV, interference/proximity galloping, wake galloping, hard and soft galloping, buffeting) utilizing passive turbulence control, cylinder proximity, and splitter plates to convert horizontal hydrokinetic energy to mechanical and subsequently to electrical energy. Back-to-back VIV and galloping result in a very broadband nonlinear oscillator capable of operating in wake synchronization for reduced velocities U*>4 and upper limit greater than 14 (limit was not identified within the testing facilities capacity).

VIVACE is an array of cylinders, which aims to mimic the kinematics of fish-schools (scales, spacing, and tails) in a simple yet effective way. Presently, 4-cylinder arrays are tested, working in full synergy, with no mechanical links, driven by flows as slow as 0.8kn. It is a highly scalable machine with applications from 1Watt to 100’s of MWatts.

ABOUT THE SPEAKER: For the past 30 years, Dr. Bernitsas has been teaching and conducting research in offshore mechanics and particularly mooring dynamics, riser/pipeline mechanics, structural dynamic redesign, and hydrodynamic forces on cylinders. Presently, he focuses on the R&D of the VIVACE Converter to harness hydrokinetic energy at high density. He is the Mortimer E. Cooley Collegiate Professor of Engineering, Prof. of Naval Architecture & Marine Engineering, Prof. of Mechanical Engineering, Director of the Marine Renewable Energy Laboratory, University of Michigan, Fellow ASME, Fellow SNAME. He is also the founder of Vortex Hydro Energy a start-up/spin-off company from his laboratory at the University of Michigan dedicated to commercializing the VIVACE Converter. His research on hydrokinetic energy harnessing and the development of VIVACE are funded by the Office of Naval Research, the National Science Foundation, the Department of Energy, the State of Michigan, etc. He received his PhD from MIT in 1979, he was awarded the Blakeley Smith Medal in 2003, served as Dept. Chair 1995-2003, and Chair of the ASME OMAE Division 2004-2005.