International Symposium on Advancements in Marine Renewable Energy (ISAMRE – 2025)

17 - 18 March 2025

SOUVENIR

NATIONAL INSTITUTE OF OCEAN TECHNOLOGY
Velachery – Tambaram Main Road, Pallikaranai,
Chennai – 600100, Tamil Nadu, India

International Symposium
on
Advancements in Marine Renewable Energy
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Organised by

NATIONAL INSTITUTE OF OCEAN TECHNOLOGY

Velachery – Tambaram Main Road, Pallikaranai,

Chennai – 600100, Tamil Nadu, India

March 2025

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Foreword

Marine Renewable Energy stands at the forefront of our pursuit of sustainable, emission-free power solutions. With India's extensive coastline and abundant marine resources, the potential to harness energy from the ocean—through tidal, wave, thermal, and salinity gradients, offshore wind, floating solar photovoltaics, and hydrogen production—is immense. Since its establishment in 1993, the National Institute of Ocean Technology (NIOT) has been a pioneer in developing indigenous technologies for harnessing ocean energy. Our work in advancing OTEC and other marine renewable energy systems is a testament to our dedication to creating sustainable energy solutions that not only reduce dependence on fossil fuels but also promote environmental stewardship and energy security.

The International Symposium on Advancements in Marine Renewable Energy (ISAMRE 2025) brings together global leaders, researchers, industry experts, and policymakers, all united in their commitment to transforming these vast marine resources into clean, reliable energy.

Over the next two days, this symposium will serve as a platform for technical exploration and knowledge exchange. The program features keynote addresses and technical sessions that delve into cutting-edge topics such as Ocean Thermal Energy Conversion (OTEC), tidal energy, wave power, and other innovative marine energy conversion technologies. These sessions are designed not only to address current challenges but also to showcase breakthrough advancements that will shape the future of sustainable energy.

As you engage with the technical content and discussions at ISAMRE 2025, I encourage you to actively share your insights and collaborate with your peers. Your participation is key to driving innovation and forging partnerships that will pave the way for a sustainable, decarbonized future utililizing marine renewable energy.

Looking forward to an engaging and enlightening symposium.

Director, NIOT

ORGANISING COMMITTEE

PATRONS

Dr. M. Ravichandran
Secretary, Ministry of Earth Sciences, GoI

Prof. Balaji Ramakrishnan
Director, NIOT

CONVENER

Dr. Purnima Jalihal
Scientist – G
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Biren Pattanaik
Scientist – E, NIOT

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Scientist – E, NIOT

National Institute of Ocean Technology (NIOT)

VISION

The National Institute of Ocean Technology (NIOT) was established in November 1993 as an autonomous society under the Ministry of Earth Sciences, Government of India. NIOT is managed by a Governing Council and the Director is the head of the Institute. Major aim of starting NIOT under the Ministry of Earth Sciences, is to develop reliable indigenous technologies to solve the various engineering problems associated with harvesting of non-living and living resources in the Indian Exclusive Economic Zone (EEZ), which is about two-thirds of the land area of India.

MISSION STATEMENT

- To develop world class technologies and their applications for sustainable utilization of ocean resources.
- To provide competitive, value added technical services and solutions to organizations working in the oceans.
- To develop a knowledge base and institutional capabilities in India for management of ocean resources and environment

KEY OBJECTIVES

- To develop technologies related to harnessing of ocean renewable energies namely wave energy, hydrokinetic energy and ocean thermal energy conversion (OTEC) and generating fresh water from seawater.
- To develop technologies for offshore structural components and establish desalination plants in the Islands of Union Territory Lakshadweep.
- To develop technology along with capacity building for the exploration and exploitation of deep ocean mineral resources such as poly-metallic manganese nodules and hydro-thermal sulphides occurring at Central and Southern Indian Ocean and gas hydrates within Exclusive Economic Zone.
- To develop acoustic systems for ocean applications such as ambient noise measurements, acoustical oceanography, underwater communication and coastal surveillance.
- To design and develop indigenous underwater acoustic imaging systems and allied technologies and to design and develop wide band underwater acoustic transducers and hydrophone arrays.
- To design, develop and demonstrate new autonomous ocean observation technologies and systems for oceanographic applications.

- To develop marine algal biotechnology, marine microbial biotechnology, open sea cage culture and ballast water treatment technologies.
- To develop environmentally sustainable solutions for beach restoration and shoreline management by integrating state-of-the-art field measurements, numerical modeling studies and comprehensive detailed engineering designs.
- To maintain the moored ocean observation network consisting of met-ocean and tsunami buoys for real time data transmission and to support RAMA program under the Indo-US collaboration and to disseminate data to INCOIS. To develop ocean observational tools prototype technology development.
- To conduct operational management and maintenance of research ships and on board scientific equipment.
- To develop and maintain a state of the art seafront research facility to enable activities in development and testing of prototype systems, validation of indigenously developed marine systems in the ocean environment

PROGRAM SCHEDULE

DATE: 17 March 2025

09:00 A.M. – 09:30 A.M.	Registration
09:30 A.M. – 10:45 A.M.	Inaugural Function
10:45 A.M. – 11:15 A.M.	HIGH TEA
Session 1: Vision on Marine energy	
11:15 A.M. – 11:45 A.M.	"Role of NIOT in Deep Ocean Mission and Blue Economy" – Director, NIOT
11:45 A.M. – 12:15 P.M.	"Significance of Marine Energy in India and at Global arena" – Dr. Purnima Jalihal, NIOT
12:15 P.M. – 12:45 P.M.	"National Policy and Vision for Renewable Energy with Specific Reference to Marine Energy" – Mr. J K Jethani, Ministry of New and Renewable Energy
12:45 P.M. – 01:15 P.M.	"Ocean Energy Systems in a Global Context" – Dr. Matthijs Soede, IEA-OES Chairperson
01:15 P.M. – 02:10 P.M.	LUNCH
Session 2: Wave, Wind and Current energy	
02:10P.M. – 02:40 P.M.	"Wave energy assessment, challenges and options in India" – Prof. Sannasiraj, IIT Madras
02:40 P.M. – 03:10 P.M.	"Marine Energy Prospects from the Indian EEZ" - Dr. Sudheer Joseph, INCOIS
03:10 P.M. – 03:30 P.M.	"Offshore wind energy : NIOT Perspectives"– Dr. S.V.S. Phani Kumar, NIOT
03:30 P.M. – 04:00 P.M.	TEA BREAK
04:00 P.M. – 04:30 P.M.	"Marine Renewable Energy for Blue Economy" – Dr. Narasimalu Srikanth, NTU Singapore
04:30 P.M. – 05:00 P.M.	"Offshore wind energy resource assessment to support the energy needs of installations along west coast of India"– Prof. Manasa Behera, IIT Bombay
05:00 P.M. – 05:30 P.M.	"Wave energy: Aspects of wave variability and nearshore dynamics" – Dr. Jayakumar Seelam, National Institute of Oceanography Goa

DATE : 18 March 2025

Session 3: Ocean Thermal Gradient	
09:30 A.M. – 10:00 A.M.	"Significance of Ocean Thermal Energy: A Baseload Renewable Power" - Patrick Grandelli, PCCI Inc, USA
10:00 A.M. – 10:30 A.M.	"Efforts on OTEC based Desalination at NIOT"– Dr. G Venkatesan, Scientist-G, NIOT
10:30 A.M. – 11:00 A.M.	"Recent OTEC Developments in Japan" – Dr. Yasuyuki Ikegami, Director IOES, Saga University, Japan
11:00 A.M. – 11:30 A.M.	HIGH TEA
Session 4: Standardization and Commercialization	
11:30 P.M. – 12:00 P.M.	"Standardisation : the essence of civilization and role of Bureau of Indian standards" – Shri Rajeev Sharma, Deputy Director General (Standards), Bureau of Indian Standards
12:00 P.M. – 12:30 P.M.	"Lab to Market: Leveraging Technology Transfer and Commercialization Strategies: Role of NRDC" - Dr. B K Sahu, National Research Development Corporation(NRDC)
12:30 P.M. – 01:00 P.M.	"International Standards (IEC TC 114) & Certification (IECRE) for the Marine Energy Industry" – Jonathan Colby, Chairperson TC 114
01:00 P.M. – 02:00 P.M.	LUNCH
Session 5: Recent Developments	
02:00 P.M. – 02:25 P.M.	"Developments in Offshore Wind Energy" – National Institute of Wind Energy
02:25 P.M. – 02:40 P.M.	"Flexible responsive systems in wave energy: An alternative to conventional WEC design" - Dr. Krishnendu, University of Plymouth
02:40 P.M. – 03:30 P.M.	Panel Discussion (Reputed Participants from MoES, Academia, Industry)
03:30 P.M. – 04:00 P.M.	Valedictory Function
04:00 P.M. – 04:30 P.M.	HIGH TEA
4:30 P.M. – 05:30 P.M.	Lab Visit

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ABSTRACTS : POSTER PRESENTATIONS BY UG / PG STUDETNS AND RESEARCHERS

ABSTRACTS:
INVITED SPEAKERS

Recent OTEC Developments in Japan

Prof. Yasuyuki Ikegami

Director, Institute of Ocean Energy, Saga University, Japan

Abstract:

Ocean Thermal Energy Conversion (OTEC) is currently moving toward a new stage worldwide. Land-based OTECs are at the technological level of commercialization and are on the verge of commercialization. Internationally, the next stage is toward the development of floating OTEC. Floating OTEC is the cheapest of the other renewable energy sources, can provide a stable power supply, and is capable of producing green hydrogen, green ammonia, and seawater desalination, so expectations are high internationally. In particular, social implementation of OTEC is urgently needed in the island regions of the world, where land is limited. SIDS, the United Nations and other allied nations in island regions, have high expectations for OTEC and have requested support for the project.

Under these circumstances, in Japan, a land-based OTEC project aiming at 1,000 kW is underway on Kumejima Island, Okinawa Prefecture, ahead of any other island in the world. Some of the new heat exchangers have already been installed. Installation of a large, large-scale deep-sea water intake pipe with a capacity of 100,000 tons per day for this purpose is also being considered.

In the Republic of Palau, a project aiming for social implementation of OTEC in 2027 has been started with the support of the Japanese Ministry of Foreign Affairs and JICA. Starting this year, new intake pipes will be installed and test trials will be conducted.

Thus, there are two main reasons why OTEC R&D is moving toward a new stage in Japan. The first is that ocean thermal energy conversion (OTEC) is the most suitable technology to provide a stable, 24-hour base power source to achieve 100% renewable energy.

In this presentation, I will discuss the trends and updates of social implementation of OTEC in Japan, and global OTEC trends along with Japanese innovations such as heat exchangers, new cycles, etc.

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Ocean Energy Systems in a Global Context

Dr. ir. Matthijs Soede

Chair, European Commision, DG Research & Innovation, Belgium

Abstract:

At the end of 2023 more than 100 countries agreed to triple renewable energy capacity by 2030 at the COP 28 climate summit in Dubai. Renewable energy is key to meeting the 2015 Paris climate agreement to limit global warming. And while renewables are already expanding fast, this latest

goal would require an even faster acceleration in the deployment of solar and wind power. However, to reach the objectives of the 2015 Paris climate agreement, leveraging all renewable energy sources is imperative. Not only wind and ocean, also the energy from the seas and oceans. Realising this goal requires a clear vision and coordinated collaborative action. The International Energy Agency (IEA) Ocean Energy Systems (OES) Technology Collaboration Platform (TCP) has an ambitious vision formulated in "Ocean Energy and Net Zero: An International Roadmap to Develop 300GW of Ocean Energy by 2050". This roadmap outlines a comprehensive strategy that will help to drive the global development of ocean energy. It is a call for action to the whole ocean energy community from government to industry and private investors. Coordinated efforts and exchange of experiences is important for accelerating the development of the ocean energy sector. An insight in the roadmap will be presented and a snapshot from the collaborative actions taken by the IEA OES TCP.

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International Standards (IEC TC 114) & Certification (IECRE) for the Marine Energy Industry

Jonathan Colby

Chair, TC 114,
Email: streamwisedev@gmail.com

Abstract:

International, consensus-based standards and certification against those standards within a global system will play a critical role in the long-term success of marine energy. The International Electrotechnical Commission (IEC) Technical Committee (TC) 114 "Marine energy - Wave, tidal and other water current converters" develops international, consensus-based standards for the marine energy industry. The "IEC System for Certification to Standards Relating to Equipment for use in Renewable Energy Applications", or the IECRE, is a global Conformity Assessment System that includes the Marine Energy Sector and supports independent, 3rd-party verification of compliance to the standards published by IEC TC 114. Taken together, IEC TC 114 and the Marine Energy Sector of the IECRE provide the standards and certification deliverables necessary to advance the industry. A summary of key developments and accomplishments within IEC TC 114 and the Marine Energy Sector of the IECRE will be provided, including an example of an IECRE Test Report (RETR) issued within the Marine Energy Sector.

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Significance of Ocean Thermal Energy – A Baseload Renewable Power

Patrick Grandelli
PCCI, Inc., USA
Email: pgrandelli@pccii.com

Abstract:

The heat stored within earth's oceans is a massive resource to generate continuous, reliable electricity. Power systems to unlock this 'baseload' non-intermittent resource have been operated at ten locations worldwide - at small scale. Like hydropower dams, Ocean Thermal Energy Conversion plant and cold seawater plants require large-scale infrastructure to generate secure, domestic, clean electricity at agreeably-low costs.

Since 2020, durable extra-large municipal pipes were developed for non-ocean customers. This new commercial technology has spurred an India-USA design study to investigate if a modern 5-megawatt OTEC plant or a larger 15 – 20 megawatt OTEC plant will generate adequate financial power at sites in India and potentially other sites worldwide.

Using these giant new pipes, the Andaman and Nicobar Islands hold promise to be the world's pioneer OTEC site with sustainable economic value. This presentation will first describe operations at two otec plants, and the attributes that lead to deep cold water sites being economically viable. These attributes are: Seawater temperature at depth and distance from shore, customer load size, willing regulators, price and existing subsidies, and decisive leadership. We can then apply the same attributes to evaluate the significant oceanographic and economic features for the Andaman and Nicobar Islands.

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Significance of Marine Energy in India and the Global Arena

Dr. Purnima Jalihal
Scientist-G & Head – Energy & Fresh Water,
National Institute of Ocean Technology, Chennai-600 100, India
E-mail: purnima@niot.res.in

Abstract:

We know that climate change is real and Green House Gas (GHG) emissions are a large anthropogenic reason for this. To reduce GHGs the move to renewables is the only alternative however we need to move beyond solar and wind. India with its long coastline and large EEZ needs to consider ocean energy as an additional mode of renewable energy. Till date in the global scenario Europe has been able to develop wave energy and tidal energy devices of fairly large scales. However commercialization is yet to happen. But there are several policies and consenting processes in place

for industry to take up the scaling up and commercialization since many devices are now beyond laboratory and have reached high TRLs. India is positioned in the globe such that the wave and current magnitudes are lower than the northern latitude. This actually has been seen to be helpful for device designs as has been seen by the NIOT devices offshore. Commercial viability of scale needs to be understood which requires capital for scaled up devices. However India also has a good temperature gradient available throughout the year which makes OTEC a good base load option.

NIOT has developed expertise in ocean thermal desalination and is now set to install the first OTEC powered desalination system in Lakshadweep. The MoES is supporting an offshore plant under the Deep Ocean Mission. The need of the hour is industry involvement and capacity building for offshore installation and operations. The first low temperature thermal desalination plant has completed two decades thus giving confidence for using the ocean thermal gradient in a sustainable manner. Marine energy can fulfill India's renewable energy needs to a large extent and needs to be taken forward.

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Marine Renewables towards Coastal Region's Sustainability & Blue Economic Growth

Dr. Narasimalu Srikanth

Programme Director, Energy Research Institute, Nanyang technological university, Singapore
Email: nsrikanth@ntu.edu.sg

Abstract:

Marine renewable energy is key to enhancing coastal sustainability and driving blue economic growth. This presentation highlights the development of tidal and floating solar energy systems tailored for tropical conditions, focusing on their applications in aquaculture and the electrification of harbour craft. Through dedicated design and deployment efforts, we address the challenges of tropical marine environments while optimizing energy efficiency and resilience. The presentation will showcase key findings from field studies, demonstrating the feasibility of integrating these renewable technologies to support sustainable maritime industries and inform policy directions for a low-carbon coastal economy.

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Wave energy: Aspects of Wave Variability and Nearshore Dynamics

Jaya Kumar Seelam
Chief Scientist, CSIR – National Institute of Oceanography, Goa
Professor, Academy of Scientific and Innovative Research, Ghaziabad, UP
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Abstract:

The International Energy Agency ranks India as the world's third-largest energy-consuming country, which is attributed to the rising incomes and improved living standards. As of March 2022, India's installed power plant capacity, including captive capacity, is 475 GW, with a Renewable plant capacity of 116.846 GW, of which 40.6 GW is contributed by wind power. While India's target of renewable energy capacity by 2030 is 500 GW, there is tremendous impetus for enhancing renewables in the country. While renewable energy is dominated by solar, wind, and hydro, the ocean has vast potential for harnessing marine renewable energy. Earlier reports show that the wave energy from the global oceans is of the order of 20-80 Peta Watt hours per year. With its vast coastline of 7500 km and EEZ of more than 2 million km2, India has a vast area to explore resources, including energy. India has conducted wave energy extraction studies, especially Oscillating Water Column-based Wave Energy Converters, late point absorbers, and tidal stream turbines. The wave energy potential along the Indian coast is approximately 40GW; however, this needs to be verified considering various factors of tidal influence, river discharge, monsoon conditions, etc. Few energy assessment studies exist based on the ECMWF database; however, based on the database length and the type of model used, there is a variation in the assessment. There is a need to assess the wave energy considering the available databases and updated coastal bathymetry. There is considerable variability in the wave energy owing to the southwest monsoon. Most of the high energy is experienced during SW monsoon, while the non-monsoon period results in an overall low energy. The Arabian Sea is found to have higher energy capacity than the Bay of Bengal, even though high energy episodes occur during the cyclones. Further, we see that the mean wave climate oscillates at decadal scales from the wave height trend studies. While offshore wave energy potential is assessed based on global wind wave models, coastal wave energy assessment studies are limited. Moreover, the variation in the wave energy between 30m water depth and 9 m water depth was about 10 to 27% lower. The influence of tide on the wave power potential is to be studied as seen from the preliminary studies, and there is a significant difference when tide and river discharge influence is accounted for.

Keywords: *marine renewables, wave power, tide influence, decadal changes, nearshore wave dynamics*

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Standardisation: the essence of civilization and role of Bureau of Indian standards

Shri. Rajeev Sharma
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Abstract:

Standardisation is the foundation of modern civilization, ensuring safety, quality, interoperability, and global trade. It plays a vital role in shaping a progressive and sustainable society by fostering technological innovation, consumer protection, and industrial growth. Bureau of Indian Standards (BIS), as India's national standardization body, is at the forefront of these efforts, developing and implementing standards that enhance product quality, facilitate regulatory compliance, and support economic development.

BIS actively contributes to both national and international standardization efforts, aligning India with global best practices while addressing local requirements. Its comprehensive framework spans multiple sectors, including electrical safety, renewable energy, manufacturing, and infrastructure. In the marine energy sector, BIS, through its Marine Energy Conversion Systems Sectional Committee (ETD 54), ensures that India's standardization initiatives align with international standards while catering to domestic industry needs. These standards promote innovation, safety, reliability, and interoperability of marine energy systems.

This session explores the critical role of standardization in modern society, the contributions of BIS in defining India's quality infrastructure, and how these efforts drive innovation, trade, and public well-being.

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Offshore wind energy resource assessment to support the energy needs of installations along west coast of India

Prof. Manasa Behera
Professor, Ocean Engineering , IIT Bombay
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Abstract:

There is a growing demand for sustainable energy solutions in line with the Net Zero target of Bharat. Several large-scale initiatives are already in progress and many sectors are exploring the need based small-scale tapping of renewable energy. A study was conducted along the west coast of Bharat that necessitates a detailed assessment of offshore wind energy potential, particularly to support offshore installations like oil platforms, etc. This study aims to evaluate wind energy resources at selective offshore locations, focusing on the importance of selecting an appropriate

climate model for predicting wind power density (WPD). Accurate future projections of wind speed and WPD are crucial for determining the viability of offshore wind projects. In this context, the study identifies the most suitable climate models among CMIP6 GCMs, the BCC-CSM2-MR model was selected due to its reliability in projecting future wind speed changes in the Arabian Sea. The theoretical WPD for various regions in the Arabian Sea was calculated, revealing annual wind speeds of 4.5-7 m/s. The selection of adaptable turbines was carried out to cater the needs, implementability and Atmanirbhar Bharat Abhiyaan. The final extractable energy was determined based on prevailing wind conditions and selected turbine specifications. This study highlights the importance of accurate resource assessments, appropriate turbine selection, and future wind predictions for sustainable offshore energy solutions along the west coast of Bharat, thereby contributing to energy security and reducing carbon emissions.

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Flexible responsive systems in wave energy-An alternative to conventional WEC design

Dr. Krishnendu Puzhukkil

Research Fellow, University of Plymouth

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Abstract:

This talk will explore novel flexible wave energy converters as a promising alternative to conventional rigid WEC designs. Flexible WECs will enhance energy capture by adapting to incident wave conditions, improving efficiency and durability. The speaker will highlight various flexible WEC designs, suitable polymer materials, and the hydro-elastic interaction of the flexible polymer materials with regular wave conditions. The hydro-elastic interaction experiment was conducted in a wave flume facility at the University of Plymouth's COAST Laboratory. For these experiments, the flexible polymer materials were immersed at a submersion depth of 108 mm from the free surface elevation and tested at a water depth of 700 mm. The results from these experiments will be presented. A brief overview of the origami-inspired flexible WEC design with capability of testing different Power-Take-Off systems and use of variable capacitance meta-materials (Dielectric Elastomer Generators and Dielectric Fluid Generators) to advance the potential of WEC design will also be presented.

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Estimates of the Marine Energy Potential from the Indian EEZ

Dr. Sudheer Joseph
Scientist – G, INCOIS
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Abstract:

The relevance of blue energy initiatives lies in their ability to harness the vast and untapped energy resources of the world's oceans. According to the International Renewable Energy Agency report, G20 countries collectively account for 81% of total renewable energy and about 100% of Ocean energy. Offshore renewable energy, such as solar, wind, wave, tidal, ocean thermal energy conversion, ocean currents and salinity gradient represent largely untapped potential for renewable. It can significantly aid in the energy transition and developing a global blue economy. The first step towards harnessing the blue energy potential is to estimate the available reserves of various forms of energy within the country's Exclusive Economic Zone (EEZ). Towards this, INCOIS has now developed an Integrated Ocean Energy assessment of the Indian EEZ. These estimates are prepared using various data sets, which include satellite measurements and model-simulated parameters verified using observations. This report can be used as guidance for industries to identify potential energy pockets before taking detailed field work for project implementation. INCOIS prepared the annual, monthly, and daily energy estimates of ocean energy components following standard methods that can also be visualized through a WebGIS interface at 5 km grid resolution. INCOIS has estimated integrated ocean energy of 9.2 Lakh TWh within the EEZ of India.

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Lab to Market: Leveraging Technology Transfer and Commercialization Strategies: Role of NRDC

Dr Bijay Kumar Sahu & Dr Bhavya Manjeera
National Research Development Corporation
An Enterprise of DSIR, Ministry of Science & Technology, Govt of India
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Abstract:

In the changing paradigm of innovation, creation, protection and management of intellectual property (IP) are the key factor in successful knowledge management, knowledge protection and knowledge monetization in leveraging lab to market. The knowledge intensive economy is heavily driven by innovations and technological competitiveness. Management of Intellectual Property Rights (IPRs) and its strategies are determining the value proposition and positions of universities, industries and academies in the global arena. The role of IP has significantly played a strategic role

in global equilibrium emanating from changing technologies, absorption and spill over. The growth of any knowledge based industries is driven by the creativity and knowledge of their people. The effective IP management, which provides incentives for innovation and creates structures for sharing the results, is the key to unlocking this human potential. The implementation of National IPR Policy 2016, India has been significantly showcasing and leveraging the rank in Global Innovation Index (GII) from 84 ranks in 2014 to 39 ranks in 2024. To leverage innovation in prospering life, NRDC has been serving the nation for over seven decades for the development, promotion of technological innovation, intellectual property management and transfer of technologies emanating from R& D organizations, Universities and academic institutions to MSMEs, industries and start-ups. It has developed a wide network with R & D organizations, industries, industry associations, etc. and collaborated with various national R&D organisations for commercialisation of the technologies. The value addition made by NRDC to the innovative technologies in the translation of innovative research into marketable industrial manufacturing technology and products has been a long way with mitigating many challenges. The expertise of network of national and international scientific bodies, industries, start-ups, MSMEs, universities, technology transfer agencies, industrial and engineering concerns ensures the entrepreneurs in receiving the advanced technology and services. NRDC's IPR protection service for their commercialisation, further development of technologies through scale-up, pilot plant development, rural technology development and promotion, cluster development, techno-entrepreneurships capacity building and etc. Technology transfer and commercialization serve as essential bridges between research innovations and industry adoption, particularly in the evolving field of marine renewable energy. During the "International Symposium on Advancement in Marine Renewable Energy", NRDC' will explore in emphasizing the structured approach of technology transfer, focusing on key elements such as patenting strategies, licensing models, and industry collaborations. Special emphasis will be placed on how IP strategies—ranging from patent pooling to technology valuation—enhance the scalability and market readiness of marine energy technologies showing case studies and success stories of NRDC commercializing NIOT developed technologies. Additionally, case studies on successful marine energy technology transfers will be presented, illustrating NRDC's role in fostering public-private partnerships and supporting start-ups, MSMEs, and research institutions. In line with blue economy mission, to propagate R&D in marine technologies have now in mission mode to achieve full-scale technologies indigenisation and commercialization. The challenges stem from diverse device operating principles, varied deployment environments (onshore, near shore, and offshore), and site-specific wave climate variations. This technological diversity has hindered convergence and standardization, slowing progress and leading to financial setbacks for many wave energy companies. Investor confidence has been further dampened by technical failures and market uncertainties. Given this dynamic and evolving landscape, a strategic approach to IP management and technology transfer is crucial for accelerating the commercialization of marine renewable energy innovations. NIOT has been at the forefront of developing innovative marine renewable solutions. However, for these technologies to reach commercial viability, structured IP protection and effective technology transfer mechanisms are essential. NRDC has been playing a key role in bridging the gap between research and industry by facilitating IP protection, licensing, and industry collaborations. The IP and technology transfer commercialization strategies for marine energy technologies employed for NIOT developed technologies is one of the milestone in catalysing the invention to innovation and also end-to-end IP and technologies commercialization services with value proposition and benefit sharing of transiting technologies from lab to land.

Keywords: *Intellectual Property Rights, Invention, R&D, Innovation & Technology Transfer, Marine Technologies*

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Efforts on OTEC based Desalination at NIOT

Dr. G. Venkatesan

Scientist – G, National Institute of Ocean Technology, Chennai

Abstract:

The National Institute of Ocean Technology (NIOT) established India's first Low Temperature Thermal Desalination (LTTD) plant at Kavaratti Island in 2005. Subsequently, LTTD plants have been implemented at Minicoy and Agatti in 2011, followed by installations at Amini, Kalpeni, Kadamat, Chetlat, and Kiltan during 2023–2024, with the aim of providing high-quality potable water to small island communities. LTTD plant at Androth Island shall be commissioned shortly. Studies have shown that potable water from these plants has significantly improved the health conditions of the island communities. Historically, these plants have been powered by the island grid. In a move toward self-reliant clean energy, NIOT is currently exploring Ocean Thermal Energy Conversion (OTEC) at Kavaratti Island to generate 100 m^3/day of fresh water. This initiative marks India's first plant to produce both power and fresh water by harnessing the naturally occurring ocean temperature gradient, thereby eliminating the need for diesel generators or any external power sources. The OTEC cycle that is used for this plant is an Open Cycle – OTEC, which mainly consist of flash chamber, turbine-generator, condenser and vacuum pump. The OTEC cycle that is used for this plant is an Open Cycle – OTEC, which mainly consist of flash chamber, turbine-generator, condenser and vacuum pump. The system is maintained at lower pressures by using a vacuum pump such that the pressure inside the flash chamber always remains below the vapour pressure of supplied warm seawater, resulting flash evaporation of a part of the supplied warm seawater. The generated vapour drives a turbine and generates electricity, before being condensed in a surface condenser using cold seawater drawn from the ocean depths. This condensed water has very low dissolved solids making it usable for domestic consumption and drinking purpose. Laboratory-scale experiments conducted at the NIOT campus have proved that OTEC is a viable

technology for islands like Lakshadweep, where deep cold seawater is available in close proximity to the shore.

NIOT has carried out bathymetry and temperature depth profile measurements around Kavaratti Island and has completed the feasibility studies. The plant location has been selected based on these studies. To reduce offshore construction, the design uniquely incorporates an onshore placement of the cold water intake pipeline unlike the existing LTTD plants. This innovative approach introduces new ideas, techniques, and technologies aimed at reducing environmental impact, capital costs, and specific energy consumption. The proof-of-concept project not only demonstrates the integration of OTEC with the desalination process but also paves the way for future renewable energy solutions, including the utilization of ocean thermal gradients and solar energy to power desalination systems.

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Offshore Wind Energy in India: MoES-NIOT Perspectives

Dr. S.V.S. Phanikumar
Scientist-G, Group Head – OSS,
National Institute of Ocean Technology, Chennai
Email: phani.niot@gov.in

Abstract:

The increased environmental awareness, energy security and depletion / saturated use of land based resources are driving the dependence on renewable energy technologies. Factors such as Strong and Consistent winds; reduced sound pollution; demand from the nearby coastal areas and potential opportunity to reduced transmission costs are also influencing the dependence. Indian government has targeted to install a capacity of about 30 GW from offshore wind. Ministry of New and Renewable Energy has identified significant wind potential along coasts of Rameshwaram and Kanyakumari in Tamil Nadu.

National Institute of Ocean Technology, under Ministry of Earth Sciences has been working on the topic as a part of its research activities. Tasks such as the assessment of the wind availability; substructure concepts for installation of offshore wind turbines; and, installation of the first offshore data collection platforms in Gulf of Khambhat (off Pipavav) and Gulf of Kutch (Jhakhau) coasts were carried out. A campaign to collect the data from UT Lakshadweep is also underway. The paper details the work being carried out in these locations.

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ABSTRACTS:
POSTER PRESENTATIONS BY
UG / PG STUDETNS AND RESEARCHERS

Real-Time Mooring Adaptation in Floating Point Absorbers: A Reinforcement Learning Framework for Fatigue Life Enhancement

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Abstract:

Mooring systems significantly influence the performance of floating point absorber wave energy converters (PAWECs), affecting both energy capture efficiency and structural integrity under real ocean conditions. This study develops a reinforcement learning (RL) framework to optimize mooring configurations for the RM3 WEC model, demonstrating a 23% improvement in fatigue life through dynamic fairlead position adjustments. The RL agent is trained in a coupled WEC-Sim-MoorDyn environment, enabling real-time adaptation to wave-current interactions while maintaining station-keeping requirements. Results indicate that the proposed method is more effective in handling nonlinear environmental challenges compared to conventional optimization approaches.

Keywords: *Point absorber; Mooring; Reinforcement learning; Optimization.*

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A Study on Advancements and Challenges in Ocean Thermal Energy Conversion (OTEC) Systems

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Abstract:

The ocean holds immense potential as a renewable energy source and Ocean Thermal Energy Conversion (OTEC) is one of the most promising ways to harness it. OTEC utilizes the temperature difference between warm surface water and cold deep water to generate electricity, offering a continuous and sustainable energy supply. This study explores the efficiency, technological advancements, and challenges of OTEC systems, highlighting their role in the global transition to clean energy. Key aspects include an analysis of closed-cycle, open-cycle, and hybrid OTEC systems, their working principles and recent innovations to improve efficiency. The research also examines the feasibility of integrating OTEC with desalination plants and hydrogen production, maximizing its impact beyond electricity generation. Additionally, we address the economic and environmental challenges of large-scale OTEC deployment, such as infrastructure costs and potential marine ecosystem effects. As climate change accelerates the demand for renewable energy, OTEC stands out as a viable and underutilized technology with vast untapped potential. By optimizing system

efficiency and addressing implementation barriers, OTEC can become a key player in the future of sustainable energy. This poster presentation aims to spark discussions on advancing OTEC research and its real-world applications for a greener tomorrow.

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Physics Guided Neural Network for Sea Surface Temperature Disturbance Prediction for Improving OTEC Plant Reliability

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Abstract:

Sea Surface Temperature (SST) plays a significant role in improving the reliability of Ocean Thermal Energy Conversion (OTEC) technology to generate power and freshwater generation from seawater. Various factors influencing SST include downward and upward shortwave and long wave radiations, momentum components etc. Accurate prediction of SST is very essential for various applications which include: climate monitoring, marine biodiversity, renewable energy production etc. Further, power and freshwater generation using ocean thermal energy conversion from sea water is highly sensitive to SST variation. Accurate prediction of SST disturbance helps to take appropriate control action to improve the reliability of OTEC plant. However, the main issues in accurate prediction of SST using traditional physics-based and data driven-based models are their generalizability and interpretability. By combining their strength Physics-Guided Neural Network (PGNN)-based model is proposed to predict SST variations at Kavaratti island (10.56°N, 72.64°E) using long-Short Term Memory (LSTM)-deep Neural Network. In this work, SST is predicted for year 2023 from year 2022 dataset. Additional inputs derived from mixed-layer heat budget equation for PGNN to improve the accuracy of prediction are surface Heat Flux, penetrating heat Flux, heat budget term, and entrainment heat flux. To improve the performance of PGNN model, the highly sensitive input variables are selected using multi co linearity analysis methods and the hyper parameters of PGNN model are optimized using Bayesian optimization technique. Finally, the performance of PGNN is compared with LSTM model. The results show that PGNN model outperforms LSTM with prediction accuracy of 38.411. This integration of physical principles improves prediction accuracy while ensuring the physically consistent.

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Offshore Wind Energy

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Abstract:

Offshore wind energy has emerged as a vital component of the global transition to renewable energy. This technology harnesses the power of wind over the ocean to generate electricity, offering a clean, reliable, and abundant source of energy. Offshore wind farms have several advantages, including stronger and more consistent winds, reduced visual impact, and lower noise pollution. However, installation and maintenance costs remain high, and technological innovations are needed to improve efficiency and reduce costs. Offshore wind is one of the most fascinating industries in the renewable energy sector and it is experiencing a remarkable growth. Offshore wind energy generation offers an opportunity in the race to decrease the dependence on fossil fuels, reduce greenhouse emissions, increase energy security and create employment opportunities. UK has proven success in offshore wind and has been enjoying the economic benefits of offshore wind since over a decade. Offshore wind energy is an emergent renewable energy industry in the United States.
KEYWORDS: Offshore Wind Energy, Renewable Energy, Sustainable Energy, Energy Transition, Energy Security, UK Offshore wind.

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IoT-based Monitoring System for optimizing OC-OTEC Plant against SST Variation to improve operational reliability

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Abstract:

Ocean Thermal Energy Conversion (OC-OTEC) is a promising power generation method for tropical islands, harnessing the temperature gradient between warm and cold seawater. This research introduces an innovative system integrating Machine Learning (ML), cloud computing, and mobile application development to enhance real-time monitoring and predictive optimization of OC-OTEC plants against Sea Surface Temperature (SST) variations in Kavaratti island, Lakshadweep. The power output of these plants depends on critical parameters such as temperature gradient between warm water and cold water, warm water and cold water flow rates, turbine speed, and turbine output, where even a single-digit percentage change can drastically affect its performance and reliability. To address this issue, this paper proposes a Long Short-Term Memory (LSTM) model to forecast SST using historical data from 2018-2021, achieving a remarkable prediction accuracy of

98.6% and MSE of 0.1046 for year 2022. This predictive capability enables proactive adjustments to optimize the process variables to maximize its efficiency and avoid component failures. Additionally, Google Cloud-based LSTMs were deployed by leveraging historical data from a laboratory-scale OC-OTEC plant at the National Institute of Ocean Technology (NIOT), Chennai. In addition, mobile application was developed using react-native, compatible with iOS and Android for real-time monitoring of key parameters of OTEC plant, displays historical trends, and integrates SST predictions and ML-based forecasts, all secured via Firebase. The app's intuitive interface, supported by chart kits, enhances decision-making by visualizing data trends and alerts. This system's scalability and adaptability makes it a game-changer for diverse OTEC setups. By coupling real-time data acquisition with predictive analytics, this work significantly boosts operational efficiency, reduces risks of component failure, and advances sustainable energy solutions. Highlighting the transformative potential of integrating ML, cloud computing, and application technology, this research sets a robust foundation for future innovations in renewable energy optimization, contributing to global sustainability goals.

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Floating Green Hydrogen-Powered Airports - A Sustainable Future for Aviation

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Abstract:

Floating Green Hydrogen-Powered Airports: A Sustainable Future for Aviation The concept of floating green hydrogen-powered airports presents a groundbreaking solution for achieving sustainability in aviation. Positioned on the ocean, these futuristic platforms integrate renewable energy technologies, including offshore wind turbines, solar panel arrays, and underwater tidal generators, to produce green hydrogen through seawater electrolysis. This hydrogen, generated entirely from renewable sources, serves as a clean and efficient fuel alternative, enabling zero-emission flights and significantly reducing aviation's carbon footprint. Strategically located along major international air routes, these floating airports can function as mid-route refueling stations, minimizing the need for onboard fuel storage and facilitating longer, uninterrupted flights. On-site hydrogen production factories enhance efficiency by reducing the environmental impact of hydrogen transportation. The infrastructure incorporates advanced technologies like robotic refueling stations, AI-powered ground vehicles, and automated drones for maintenance, ensuring operational efficiency and safety. In addition to reducing emissions, these platforms address land scarcity issues by providing ocean-based infrastructure, relieving pressure on overburdened terrestrial airports. They also contribute to a global shift toward sustainable energy economies by producing and storing

green hydrogen, which can be supplied to other industries as well. Despite challenges such as high development costs, technological hurdles, and the need for global regulatory frameworks, the potential of this concept to revolutionize aviation is immense. It supports international efforts to achieve net-zero emissions by 2050 and can inspire the development of other floating renewable energy infrastructures. In conclusion, floating green hydrogen-powered airports represent a visionary fusion of renewable energy and advanced aviation technology. By addressing both the carbon emissions crisis and infrastructure limitations, these innovative platforms could redefine the future of air travel while setting new benchmarks for global sustainability.

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Green hydrogen: Powering a Sustainable Future

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Abstract:

Green Hydrogen: Powering a Sustainable Future Green hydrogen is emerging as a game-changer in the global transition toward clean and sustainable energy. Produced through the electrolysis of water using renewable energy sources like solar, wind, or hydropower, green hydrogen offers a carbon-free alternative to traditional hydrogen production methods that rely on fossil fuels. This clean energy carrier holds the potential to decarbonize sectors that are hard to electrify, including heavy industries like steel, cement, and chemicals, as well as long-haul transportation such as shipping and aviation. One of green hydrogen's most promising features is its ability to store excess renewable energy, which can be converted back into electricity when needed, thus stabilizing power grids and reducing reliance on fossil fuels. Additionally, it can be blended with natural gas or used directly in fuel cells to generate electricity with zero emissions. Despite its potential, challenges remain in scaling up green hydrogen production due to high costs, infrastructure needs, and technological limitations. However, with falling renewable energy prices, advancements in electrolyzer efficiency, and growing governmental and industrial support, green hydrogen is becoming increasingly viable. This poster explores the fundamentals of green hydrogen production, its diverse applications, and its role in achieving global climate goals. It also highlights ongoing innovations, economic opportunities, and the collaborative efforts needed between governments, industries, and researchers to unlock its full potential. As the world strives for net-zero emissions, green hydrogen stands out as a vital pillar for a cleaner, more resilient and sustainable energy future.

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Analysis of Separation Efficiency in Low Thermal Desalination Demisters

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Abstract:

This study optimizes demister designs to enhance separation efficiency while minimizing pressure loss in the Low-Temperature Thermal Desalination process. The performance of three common types of demisters—hook-free, hook, and wire mesh—used to remove liquid droplets from gas flows is modeled and analyzed. The droplet dynamics within the gas flow are simulated using a discrete phase model for two-phase flow analysis. The study applies the realizable k-epsilon model and Rosin-Rammler size distribution to examine the effects of inlet velocity and droplet size on pressure drop and separation efficiency. The hook demister demonstrated the highest separation efficiency at 98%, albeit with a significant pressure drop of 3745.9 Pa, outperforming the other types. Larger droplets are captured mainly in the initial stages, with the liquid film expanding backward as the velocity increases. Despite causing a higher pressure drop, the hook demister achieves superior separation efficiency compared to the hook-free and wire mesh demisters. In contrast, the wire mesh demisters offer a balanced performance with a 90% separation efficiency and a pressure drop of 1875.7 Pa. The analysis thoroughly evaluates the effects of demister design on separation efficiency using velocity contours, pressure contours, turbulence kinetic energy, and turbulence viscosity. Keywords: Separation efficiency; Pressure drop; Demisters; Discrete Phase Modeling Low-Temperature Thermal Desalination.

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Optimizing Marine Energy with AI

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Abstract:

Moored buoys play a crucial role in monitoring ocean conditions, providing essential data for marine renewable energy applications such as wave and tidal energy systems. This study applies Long Short-Term Memory (LSTM) networks to analyze over a decade of oceanographic data, addressing challenges like missing values, sensor failures, and extreme weather anomalies. By leveraging machine learning for time-series forecasting, the research enhances the prediction

accuracy of key ocean parameters, including wave height, current speed, and extreme event detection. This project is particularly valuable for marine energy applications, as accurate ocean condition forecasting can optimize energy extraction, improve yield estimation, and enhance the operational reliability of offshore energy infrastructure. Advanced data pre processing and feature selection techniques enabled a 95% accuracy in predictions, improving traditional forecasting methods by 30%. By integrating AI-driven approaches with ocean technology, this research contributes to the advancement of sustainable marine energy solutions, ensuring efficient and resilient offshore energy systems.

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Sea trail of wave energy-based hydrogen production

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Abstract:

Currently, most of the hydrogen is produced via steam methane reforming process using methane as the raw material. Green hydrogen contributes to less than 1 percent of global hydrogen production. Green hydrogen produced via proton exchange membrane (PEM) electrolysis, has higher purity and energy density. In this process, an electrolyzer is used to electrochemically split water into its constituents, giving hydrogen and oxygen as the product. However, this process requires an ample amount of energy and water. Oceans cover more than 70 per cent of the globe and hold tremendous untapped wave energy. Wave energy is a predictable renewable energy source that can be harnessed throughout the day, unlike solar and wind energy. A two-body floating point absorber wave energy converter (PAWEC) consists of a cylindrical buoy, spar, and mooring. In the PAWEC, the buoy serves as the action body, while the spar and mooring act as reaction bodies. When the device interacts with waves, the buoy rides the wave and taps wave energy, converting wave energy into the potential and kinetic energy of the buoy. The reaction bodies provide minimal motion and higher relative motion to the device. A power take-off (PTO) mechanism is connected between the action and reaction body, converting their relative motion into electricity. As the electricity harnessed has fluctuations due to irregular waves, the energy is first stored in a battery and then connected to an electrolyzer. One molar potassium hydroxide (KOH) is prepared as the electrolyte for the electrolyzer. The electrolysis voltage is maintained at 2.1 V and 0.2 amp to split water into hydrogen and oxygen. The experiments were conducted in the wave basin at IIT Madras and an open sea trial at Vizag port, India.

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Energy from Tidal Gradient (OTEC)

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Abstract:

Offshore wind energy is a powerful source of renewable energy, but wind turbines face constant challenges like harsh weather, mechanical stress, and high maintenance costs. The poster portraits on making wind turbines more efficient and reducing damage by integrating Ocean Thermal Energy Conversion (OTEC) technology with AI-powered monitoring and predictive maintenance systems. OTEC works by using the natural temperature difference between warm surface water and cold deep water to generate electricity. When combined with offshore wind power, it creates a more stable and efficient energy system. However, offshore wind turbines are exposed to strong winds, saltwater corrosion, and unpredictable weather, which can lead to frequent breakdowns and costly repairs. To solve this, we use smart sensors and AI analytics to continuously monitor wind speed, turbine vibrations, and structural stress in real time. One of the key benefits of this system is Predictive Maintenance. Instead of waiting for something to break, AI analyzes data to detect early warning signs of mechanical failure. "Empowering maintenance teams to catch the whispers of small issues before they roar into major challenges.", reducing downtime and cutting repair costs. The AI system also automatically adjusts turbine settings to reduce wear and tear, extending the turbine's lifespan. By combining OTEC, AI, and real-time monitoring ,The project portrays offshore wind farms as more reliable, cost-effective, and sustainable. It helps prevent unexpected failures, ensures continuous clean energy production, and reduces environmental impact. The poster supports the global shift toward sustainable energy solutions, ensuring offshore wind farms remain a long-term dependable source for clean renewable power.

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ZnO based TFT for NH3 gas sensing in marine environments

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Abstract:

Ammonia (NH_3) gas sensing is crucial for environmental monitoring and industrial applications. In this study, we present the fabrication and characterization of a Zinc Oxide (ZnO)-based Thin-Film Transistor (TFT) as a highly sensitive ammonia gas sensor. ZnO, a wide-bandgap semiconductor, offers excellent chemical stability, high electron mobility, and superior gas-sensing properties. The TFT device is fabricated using a bottom-gate configuration, with ZnO as the active channel layer. The electrical response of the device is analyzed under varying ammonia concentrations, demonstrating a significant shift in threshold voltage and drain current. The sensor exhibits high selectivity, fast response/recovery time, and reliable performance at room temperature. This work highlights the potential of ZnO TFTs as an efficient platform for real-time ammonia detection in industrial and environmental settings.

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Design & Optimization of Truncated Mooring lines for OTEC Truss SPAR

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Abstract:

To overcome the dimensional constraints of physical model testing, a truncated equivalent water depth methodology was developed for a truss SPAR originally designed for a full-depth operation of 1200 m. The water depth was systematically reduced to 600 m and subsequently to 180 m, with corresponding adjustments to mooring line properties, including length, axial stiffness, and mass per unit length, ensuring dynamic consistency. Truncation rules and governing formulas were adapted from existing research, with strategic modifications to enhance the fidelity of the truncated system because of variation in type of floater and mooring system. A comprehensive analysis, encompassing both static calibration and time-domain coupled dynamic simulations, was conducted to validate the methodology. The mooring system was modelled using a quasi-static approach, and results demonstrated a strong agreement between the truncated model and full-scale prototype, both in terms of global response and mooring line forces. The proposed truncation framework has proven to be a robust and reliable approach, effectively replicating the hydrodynamic and structural behaviour of the full-depth system while enabling practical physical testing.

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Micro tidal energy hubs for remote coastal villages

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Abstract:

In many isolated coastal villages, unreliable energy limits opportunities for economic growth, healthcare, and education. Our Smart Micro-Tidal Energy Hubs offer a sustainable solution by harnessing ocean currents through low-cost hydrokinetic turbines. What makes these hubs

revolutionary is the integration of AI, which optimizes energy production, storage, and distribution. AI ensures that power flows where it's needed most—whether in homes, schools, or businesses—maximizing efficiency even during low tides. It predicts tidal patterns, analyzes weather data, and enhances battery storage, ensuring a steady and reliable power supply. Additionally, AI-driven predictive maintenance helps detect potential issues before they escalate, reducing downtime and repair costs. Unlike large tidal power plants, our system is modular, easy to install, and effective even in shallow waters, making it an ideal solution for coastal communities in developing nations. By combining AI with renewable ocean energy, we're not just generating power—we're empowering communities, improving livelihoods, and paving the way for a cleaner, more sustainable future.

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Investigating the Efficiency of a Breakwater-Integrated Wave Energy Converter in Irregular Waves

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Abstract:

Tapping into ocean wave energy offers a sustainable and clean alternative to renewable power generation. Integrating wave energy devices with coastal structures offers a cost-effective approach to wave energy development while providing additional shared benefits. This study examines the performance of a heaving spherical point absorber wave energy converter (WEC) in irregular waves through both experimental and numerical analysis. Building on fundamental investigations in regular waves, it is crucial to test WEC models in more realistic conditions before progressing to sea trials. The study evaluates a 1:30 scale model in irregular waves under two scenarios: (1) the model heaving alone and (2) the model heaving within a chambered breakwater. Irregular waves are generated using a modified JONSWAP spectrum tailored to Indian coastal conditions. Findings reveal that the WEC model integrated with the chambered breakwater generates 40.25% more power than the standalone heaving model in irregular sea states. However, its overall performance is lower compared to operations in regular waves.

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AI-Integrated Floating Solar Photovoltaic for Sustainable Fish Migration

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Abstract:

Floating Solar Photovoltaic (FSP) technology is an innovative solution for renewable energy generation, utilizing water bodies to install solar panels and reduce land usage. However, large-scale deployment of FSP systems can significantly impact aquatic ecosystems by altering fish migration patterns, water temperature, and oxygen levels. This project integrates Artificial Intelligence (AI), IoT sensors, and machine learning to minimize these ecological disruptions while enhancing energy efficiency. The proposed system uses AI-powered underwater cameras and IoT sensors to monitor real-time fish movement, ensuring that solar panel placement does not obstruct migration routes. Machine learning algorithms analyze environmental data, adjusting the floating solar panel positions dynamically to maintain optimal water conditions. AI-driven predictive models forecast temperature and oxygen level changes, enabling proactive aeration and water quality adjustments. Automated aeration systems stabilize oxygen levels, counteracting the shading effects of solar panels. Additionally, AI-powered digital twins simulate the impact of FSP systems on aquatic life, allowing for better planning and reduced ecological harm. The expected outcomes of this project include a 90% reduction in disruptions to fish migration, stable oxygen and temperature levels, and a 25% improvement in solar energy efficiency. By leveraging AI-driven solutions, this project ensures a sustainable balance between renewable energy production and marine ecosystem preservation. The scalable and eco-friendly nature of this approach makes it a pioneering model for future FSP installations worldwide, promoting cleaner energy without compromising biodiversity.

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Numerical Modeling in PRO

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Abstract:

Numerical Modeling In PRO Pressure Retarded Osmosis (PRO) is an emerging renewable energy technology that utilizes salinity gradient energy to generate power. In PRO, a semipermeable membrane separates freshwater (feed solution) from saline water (draw solution), allowing water to permeate and drive a turbine. However, system efficiency is significantly affected by osmotic pressure differences, membrane properties, and inhibitive factors such as concentration polarization and reverse salt flux. This study presents a numerical modeling approach to evaluate and optimize PRO membrane performance. A modified flux expression, incorporating internal and external concentration polarization effects along with reverse salt flux, is solved iteratively to determine water flux and power density under varying operating pressures. Initially, a fixed-point iteration technique was used, but due to convergence issues and overflow errors from large exponentials, Brent's method was adopted. This method provided guaranteed convergence, and improved computational efficiency by eliminating iterative loops. Key membrane parameters—including water permeability (A), salt permeability (B), structural parameter (S), and mass transfer coefficient (k)—are to be estimated through laboratory experiments using crossflow reverse osmosis setups. Locally synthesized membranes based on Polyacrylonitrile (PAN) and Cellulose Acetate (CA) are to be tested, and power density curves were generated based on previous values of membrane parameters.The model facilitated performance comparisons among different membrane configurations and provided insights into optimal operating conditions. Results highlight the influence of membrane characteristics on power density, emphasizing the need for high permeability and minimal reverse salt flux. The model can also be extended to hybrid PRO-desalination systems. Future work includes experimental validation, computational fluid dynamics (CFD) modeling for spacer optimization, and assessing the feasibility of large-scale PRO applications. This research advances PRO technology by offering a robust numerical tool for membrane evaluation, supporting the development of scalable energy recovery solutions.

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Experimental Investigation of Hydrodynamic Efficiency and Energy Conversion in an Oscillating Water Column

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Abstract:

The increasing global demand for renewable energy has intensified interest in harnessing ocean wave energy, given its consistency and abundance. Among various wave energy converter (WEC) technologies, the Oscillating Water Column (OWC) is considered one of the most promising due to its structural simplicity and efficient energy conversion potential. This study presents an experimental investigation into the hydrodynamic and electrical power response of an OWC operating under Power Take-Off (PTO) damping, facilitated by a Wells turbine. Physical model tests were conducted in a controlled wave flume environment, where regular wave conditions were varied, focusing on a circular bottom profile configuration. The selection of the d/L ratio was based on previous studies to ensure optimal hydrodynamic performance. The experimental setup comprised pressure sensors, a data acquisition (DAQ) system, and a custom-built DAQ system dedicated to measuring electrical power output. A Pitot tube was employed to assess airflow velocity through the orifice. Key performance metrics, including hydrodynamic efficiency, wave amplification factor, chamber pressure fluctuations, oscillatory behaviour, and electrical power generation, were systematically analysed. The maximum hydrodynamic efficiency achieved was 0.64, while the wave-to-wire efficiency was determined to be 0.034. Although power generation was observed, the absence of Reynolds number scaling resulted in a relatively low overall power output, despite the successful characterization of a power profile. The findings of this study highlight the influence of PTO damping on wave energy absorption and conversion, offering insights into the optimization of OWCs for improved efficiency. Identified limitations, including scaling constraints and potential enhancements in turbine performance, provide directions for future research. These results contribute to the ongoing development of OWC technology and offer practical recommendations for advancing real-world wave energy extraction systems. Keywords: Oscillating Water Column, Wave Energy Converter, Power Take-Off Damping, Wells Turbine, Hydrodynamic Efficiency.

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Performance of a Taut Mooring System for a 5MW SPAR FOWT in Deep Waters Under Normal and Extreme Conditions

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Abstract:

Due to the consistent and strong wind speeds with less turbulence, offshore wind energy extraction is becoming more popular in the past few years. Floating offshore platforms are best suited for hosting a wind turbine in the deeper waters. Mooring systems are adopted to hold these platforms in the sea by preventing its drift. Conventional oil and gas industry uses slack mooring system for SSP and SPAR platforms. The usage of taut or semi-taut mooring is gaining attention due to its lesser footprint and reduced mooring cost. Thus, in this study, a taut mooring system is adopted for a 5MW SPAR FOWT to understand its performance in restraining the motions and power generation. A coupled aero-hydrodynamic analysis is performed for a wind turbine operating condition at rated wind speed under normal and freak wave scenarios. This study highlights the effects of different taut mooring line material, namely polyester and nylon. These findings help to provide practical support and reference for the application of taut mooring system in deeper water for SPAR FOWTs under normal and extreme sea states.

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Synergistic Bio-Photovoltaic Systems Integrating Marine Microalgae and Cyanobacteria for Sustainable Energy and Feedstock Production

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Abstract:

Bio-photovoltaic's (BPV) represents a sustainable energy technology that harnesses photosynthetic organisms for renewable energy production and multiple applications. The role of cyanobacteria in BPV applications has been particularly emphasized due to their potential contribution to the transition toward clean and renewable energy along with the carbon capture process. In this study, microalgae and cyanobacteria were collected and isolated from their natural environments, as both organisms contribute to BPV systems. This study investigates the synergistic interaction between oxygenic microalgae and cyanobacteria within a dual-chamber BPV with various circadian rhythms of light in which the algae was subjected to grow in various light/dark cycles (12L/12D, 10L/14D, 14L/10 D, 24L/0D) to attain maximum biomass feedstock for various biorefinery processes and energy production. The objective is to identify the most suitable microorganisms for sustainable BPV applications. The photosynthetic efficiency and bio energy potential are compared by assessing phycobilin, chlorophyll content, carotenoid levels, DCPIP (2,6-dichlorophenolindophenol) reduction, antioxidants (DPPH, Phosphomolybdenum) and lipids. This system offers a holistic approach by providing biomass for multiple applications, with extended light exposure proving effective in enhancing lipid synthesis and reducing organism doubling time. The preliminary results from the isolation of microalgae and cyanobacteria from marine habitats, scaleup, and light-intensity studies provide valuable insights into optimizing BPV systems by leveraging the distinct metabolic capabilities of microalgae and cyanobacteria contributing to the advancement of eco-friendly bioenergy solutions as a viable alternative to meet the growing global energy demand. Keywords: Bio-Photovoltaic systems, circadian rhythm of light, cyanobacteria, microalgae, sustainable energy.

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Hydrogen Production from Marine Microalgae and Cyanobacteria through Photo production and Dark fermentation in Seawater-Based Systems

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Abstract:

Hydrogen is gaining prominence as a clean and efficient renewable energy source, yet conventional production methods face challenges such as low conversion efficiency and high resource demands. Marine bioresources, particularly microalgae and cyanobacteria, offer a sustainable alternative through seawater-based cultivation, integrating photobiological and fermentation-driven hydrogen production with minimal freshwater and nutrient input. Their ability to efficiently fix CO_2, harness solar energy, and thrive in marine environments makes them ideal candidates for large-scale hydrogen generation and multiple biorefinery applications. This study investigates the potential of oxygenic microalgae and cyanobacteria cultivated in seawater under varied light cycles (12L/12D, 10L/14D, 14L/10D, 24L/0D) to optimize biomass accumulation and photo-hydrogen production. Photosynthetic efficiency is assessed through phycobilin, chlorophyll, and carotenoid analysis, while dark fermentation efficiency is evaluated via metabolic byproduct profiling, emphasizing acetate- and butyrate-driven pathways. Hydrogen yields are quantified using hydrogenase activity assays and gas chromatography. This integrated system enhances biomass utilization for biorefineries and biopolymer production. Insights from strain isolation, scale-up studies, and light-intensity optimization contribute to advancing seawater-based biohydrogen production, offering a scalable and eco-friendly solution to meet global renewable energy demands.
Keywords: Biohydrogen; Marine Bioresource; Microalgae and Cyanobacteria; Seawater based Renewable energy; Zero emission clean fuel.

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Seaweed-Infused Bio-Membranes for Advancing Blue Energy Harvesting

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Biotechnology, Vel Tech High Tech Dr.Rangarajan Dr.Sakunthala Engineering College
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Abstract:

The effectiveness of Pressure Retarded Osmosis (PRO), a potential method for capturing energy from salinity gradients, is primarily reliant on membrane performance. By creating a bio-semi-permeable membrane with seaweed-based biopolymers, this effort seeks to increase membrane

efficiency. Superior hydrophilicity, biocompatibility, and antifouling qualities provided by seaweed-derived materials can enhance water flux and slow membrane deterioration over time. Seaweed extracts are included into standard membrane production procedures as part of the study, and the permeability, selectivity, and mechanical stability of the modified membrane are assessed. The goal of the research is to enhance energy extraction while maintaining sustainability and cost-effectiveness by optimizing membrane composition through laboratory-scale testing. The results may help develop osmotic power technology as a renewable energy source that is both environmentally friendly and scalable.

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Green Hydrogen and Benefits

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Abstract:

The poster titled "Green Hydrogen and Benefits" presents an informative overview of the advantages, economic aspects, and environmental impact of green hydrogen as a sustainable energy source. It highlights green hydrogen as a clean, renewable, and powerful fuel that offers zero emissions and limitless potential, making it a key player in the transition to a greener future. The benefits section outlines the core advantages of green hydrogen, emphasizing its ability to eliminate carbon emissions, provide renewable energy, and support diverse applications while reducing reliance on fossil fuels. Additionally, it plays a crucial role in combating climate change and fostering sustainability. The economic aspects section explores the role of green hydrogen in job creation, cost reduction, and energy independence. It also emphasizes the potential for government support and the overall positive impact on the green economy, making it a viable solution for future energy markets. The environmental impact of green hydrogen is another key focus, emphasizing its zero emissions, clean energy attributes, and potential to reduce pollution. It highlights how green hydrogen can preserve nature, power a sustainable future, and contribute to a healthier planet without causing environmental harm. Lastly, the hydropower revolution section calls for global support for green hydrogen. It encourages embracing renewable energy, advocating for hydrogen solutions, educating communities, and fostering international cooperation to accelerate the green transition. Through visually engaging elements and concise information, the poster effectively communicates the significance of green hydrogen in shaping a cleaner, more sustainable, and economically viable future.

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Evaluation of Operational Conditions for Offshore Structures Supporting OTEC Platforms in the North Indian Ocean Basin

D Satish Kumar, Manasa Ranjan Behera, V.K. Srineash, Ashwani Vishwanath, Purnima Jalihal

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Abstract:

The safety of individual components mounted on offshore platforms are conventionally ensured by designing them to withstand extreme wind, wave and current loadings for a particular return period. The wave conditions in particular are aggravated during cyclone occurrence because of the surge-induced increase in the level of water which creates considerable deviations in significant wave height. The current study is aimed at assessing the storm wave characteristics for operational criteria of offshore platforms in the North Indian Ocean basin. The wave characteristics is assessed using coupled ocean circulation model ADCIRC and wave model SWAN at a prominent offshore location in the Arabian sea (within the Indian Exclusive Economic Zone (EEZ)) for return periods namely 30-, 50- and 100-year. The model domain is initially validated for Cyclone Ockhi event, where simulated and observed significant wave heights had a correlation coefficient around 0.9 at offshore moored buoy location. The validated domain was subsequently forced with cyclone events of aforementioned return period on a hypothetical track developed to attain maximum wave heights at the considered site. The intensity of the hypothetical cyclone events is defined using established Probable Maximum Tropical Cyclone parameters namely central pressure drop and maximum sustained wind speed derived from extreme value analysis of cyclone data in the Arabian sea. The peak significant wave heights were about 13.14 m, 14.01 m and 15.10 m for 30-, 50- and 100-year, respectively which is about 30%, 40% and 50% higher than those obtained from using actual Ockhi cyclone parameters. Similarly, the peak wave period was estimated to be 13.34 s, 13.76 s and 14.19s. The operational wave characteristics thereby derived from the above analysis is vital for structural design of offshore platform that shelters renewable energy installations, like OTEC power plants.

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Numerical simulation of normal and extreme sea states for assessing the hydrodynamic performance of ocean energy structures

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Abstract:

The ocean presents a vast and largely untapped source of renewable energy through thermal gradients, wave motion, tides, and offshore wind. As global interest in marine renewables grows, India, with its extensive coastline, holds significant potential for harnessing ocean energy to meet its rising energy demands. While numerous studies have focused on the performance of ocean energy structures in regular wave conditions, research on their efficiency and survivability under realistic and extreme sea states remains limited. To bridge this gap, it is essential to assess their survivability and resilience in site-specific environments. Building upon this, the present study aims to numerically simulate different sea states, including normal and extreme conditions, using the Delft3D modelling suite. The simulation incorporates key parameters such as bathymetry (GEBCO), wind forcing (ECMWF and JTWC track data), water level variations (Global tidal model), and wave characteristics (ECMWF reanalysis data). The Delft3D model is validated against measured data from the Indian National Centre for Ocean Information Services (INCOIS) to ensure accuracy and reliability. This current study will be extended to evaluate the performance of different ocean structures for varying sea conditions in selected regions along the West coast of India by utilizing simulated sea states from Delft3D. The study will provide valuable insights into the feasibility of the structures in extreme marine environments, offering guidance for the design, optimization, and deployment of different technologies. By addressing the gap in understanding structural response of marine renewables under extreme sea states, this research contributes to the advancement of sustainable ocean energy solutions.

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Response Analysis for Spar Platform With Cold Water Pipe

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Abstract:

The ocean holds immense potential for marine renewable energy, with its total capacity far exceeding global demand. Among various ocean energy sources, the thermal gradient offers the second-highest potential. As a tropical country, India has significant opportunities for energy generation from thermal gradients. For commercial viability, floating platforms are essential, and

the long cold water pipe (CWP), which transports deep-sea cold water, plays a crucial role in platform dynamics. This study examines the motion response of a spar platform with and without a CWP. A classic cylindrical spar was modelled in ANSYS AQWA to analyse surge, heave, and pitch responses under both conditions. The CWP was represented as a tube element rigidly fixed to the platform, with the clump weight modelled as a point mass at its end. Results indicate that platform motion is reduced when the CWP is included, demonstrating its significant influence. Understanding the exact impact of CWP dynamics requires further investigation through coupled simulations or experimental studies. Future work should focus on the interaction between the CWP and platform, considering varying environmental conditions and structural parameters. A more comprehensive analysis will help optimize floating platform designs for efficient and stable ocean thermal energy conversion.

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Extracting Agricultural Waste from The Ocean Using Marine Renewable Energy

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Abstract:

Abstract Marine pollution caused by agricultural waste is a growing environmental concern, affecting marine ecosystems, biodiversity, and human livelihoods. Waste such as fertilizers, pesticides, and organic residues from agricultural activities often find their way into oceans, leading to water contamination, eutrophication, and habitat destruction. This project proposes an innovative solution by integrating marine renewable energy (MRE) technologies with automated waste collection systems to extract agricultural waste from the ocean sustainably. Our approach utilizes a specially designed waste-collecting ship powered by a combination of offshore wind energy, tidal energy, wave energy converters, and floating solar photovoltaic systems . The ship is equipped with advanced filtration and segregation mechanisms to efficiently collect, process, and recycle floating agricultural waste. The renewable energy sources ensure that the waste extraction process is self-sustaining, reducing dependency on fossil fuels and minimizing further environmental impact. The system works by deploying floating waste collection units that operate autonomously, gathering waste from large oceanic regions. These units transfer the waste to the main ship, where it undergoes filtration and categorization into biodegradable and non-biodegradable components. Biodegradable waste can be processed into organic fertilizers or biofuels , while non-biodegradable waste is sent for recycling and repurposing . The proposed solution offers multiple benefits , including reducing ocean pollution, protecting marine biodiversity, and promoting a circular economy by recycling agricultural waste into valuable resources. Additionally, the integration of

MRE technologies ensures an environmentally friendly and energy-efficient approach to waste management in marine environments. By combining advanced AI-powered waste detection, automated collection mechanisms, and renewable energy , this project provides a scalable and sustainable solution to address the pressing issue of agricultural waste pollution in the ocean. It supports global sustainability goals, ensuring cleaner oceans and a healthier planet for future generations.

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Tidal Energy (Harnessing the power of Tides)

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Abstract:

Tidal power, a clean and renewable energy source, is of tremendous potential in the worlds transition to clean energy solutions. Our poster is a visual representation of this idea in an artistic and reflective design, with Earth depicted as a globe resting on a vertical axis buoy, representing the importance of ocean-based energy. A regal blue whale in the background and colorful corals at the bottom highlight the coexistence of marine ecosystems and clean energy solutions. We selected tidal power as our topic due to its reliability, predictability, and vast reserves yet to be exploited. In contrast to solar and wind power, which are weather-sensitive, tidal power is controlled by gravitational forces between the Earth, Moon, and Sun and is therefore very consistent. Tidal power has limitations owing to technological, economic, and environmental concerns, despite its shortcomings. Our goal is to emphasize the viability of tidal power while addressing the call for sustainable techniques for preserving marine biodiversity. With this poster, we hope to raise awareness about tidal energys contribution to avoiding fossil fuel reliance and carbon emissions reduction. The graphic metaphor of Earth being held up by the vertical buoy illustrates the vital function that oceans play in keeping the planets ecology in balance and supporting human existence. Having a blue whale, one of the worlds biggest sea animals, on the poster symbolizes the inherent bond between ocean health and energy solutions. Corals, also referred to as the "rainforests of the sea," remind us of the delicate elegance of ocean life and the necessity of reducing the environmental footprint when tapping into the power of the ocean. Through this visually stimulating and informative piece, we would like to spur innovation and investment in this clean energy industry toward a greener future for the world.

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The Powerhouse of Ocean-Harnessing Thermal Energy

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Abstract:

This poster painting depicts the immense potential of two innovations i.e.UTEC and thermal desalination. The painting is divided into 3 parts. The left side consists of humans in two segments using fresh water and non clean water and the differences below the complete process of thermal desalination in various steps . This poster includes catchy headlines subheading in bold red and use of bright colours and big figures to draw the attention. The other section consists of before and after the use of thermal energy and how it benefits the city and for household works. This is a tribute to harmony between technology and nature proving that future of clean energy and fresh water in already within our reach.

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Hydrogen from Marine Renewable energy

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Abstract:

Hydrogen production from Marine Renewable Energy (MRE) sources represents a transformative pathway toward sustainable energy systems, offering a viable solution to global energy and environmental challenges. This presentation explores the integration of MRE technologies—such as offshore wind, tidal energy, wave energy, and ocean thermal energy—with hydrogen production methods, including electrolysis and thermochemical processes. Offshore wind turbines harness powerful ocean winds, tidal energy systems capture the predictable rise and fall of tides, wave energy converters utilize the kinetic energy of ocean waves, and ocean thermal energy conversion exploits temperature gradients between surface and deep waters. These MRE sources provide renewable electricity and heat, enabling the production of hydrogen as a clean, versatile, and sustainable energy carrier. The benefits of hydrogen production from MRE sources are substantial. It offers a pathway to zero greenhouse gas emissions, enhances energy storage capabilities, and provides a means to stabilize power grids by addressing intermittency issues associated with renewable energy. Hydrogen can be stored, transported, and utilized across various sectors, including transportation (e.g., fuel cell vehicles), power generation (e.g., gas turbines and fuel cells), and industrial processes (e.g., ammonia production and refining). However, significant

challenges remain, including the technical complexity of integrating MRE systems with hydrogen production infrastructure, high upfront capital costs, and the need for energy-efficient technologies to minimize losses during production and storage. This presentation will highlight the potential of MRE-driven hydrogen production to advance global decarbonization efforts, emphasizing its role in achieving a sustainable and resilient energy future. By addressing these challenges and leveraging the vast potential of MRE sources, hydrogen production can play a pivotal role in the global transition to a low-carbon.

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Blue Energy from Salinity Gradient Using Pressure Retarded Osmosis

Fahad Peerali Paloth, Shanmukha Rao Ganta; Fahad Peerali Paloth; Manohar Lal; K. Barath Kanna; Yavvari Shireesha; Sushil Ram; Sudeshna Thombare; V.K.Srineash; Subramaniam Chandramouli,

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Abstract:

As conventional energy sources become increasingly scarce, there is a growing focus on renewable and blue energy. Blue energy, derived from the ocean, offers abundant resources. Pressure retarded osmosis (PRO), a promising technique for capturing blue energy, uses the salinity gradient to produce electricity. PRO is a more effective energy production method than reverse electro dialysis (RED) since it has demonstrated a significantly higher power density. Furthermore, the salinity gradient provides continuous base-load power generation. The main sources of energy from the salinity gradient is the osmotic potential available along the natural processes such as coastal mixing of sea-river and physical processes such as desalination. The work carried out by membranes to transport water from low to high hydraulic potential is converted as mechanical energy. The current study uses PRO in a bench-scale system to investigate energy generation from a salinity gradient. The low saline solutions are deionized water (DI) and 1 milli-molar NaCl (river water), while the high saline solution is a 1 molar NaCl solution (RO brine). The experiment uses cellulose triacetate (CTA) FTSH2O flat sheet semi permeable membranes. According to the findings, the greatest power density that can be attained is 3.6 W/m^2 with an applied hydraulic pressure difference of 17 bar.

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Harnessing Wave Energy by Integration of Piezoelectric Wave Energy Converters with Coastal Structures

Kruthik Prem Gowda HM, Prof. Srineash VK,
Civil Engineering Department, Indian Institute of Technology Bombay
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Abstract:

Abstract Marine pollution caused by agricultural waste is a growing environmental concern, affecting marine ecosystems, biodiversity, and human livelihoods. Waste such as fertilizers, pesticides, and organic residues from agricultural activities often find their way into oceans, leading to water contamination, eutrophication, and habitat destruction. This project proposes an innovative solution by integrating marine renewable energy (MRE) technologies with automated waste collection systems to extract agricultural waste from the ocean sustainably. Our approach utilizes a specially designed waste-collecting ship powered by a combination of offshore wind energy, tidal energy, wave energy converters, and floating solar photovoltaic systems . The ship is equipped with advanced filtration and segregation mechanisms to efficiently collect, process, and recycle floating agricultural waste. The renewable energy sources ensure that the waste extraction process is self-sustaining, reducing dependency on fossil fuels and minimizing further environmental impact. The system works by deploying floating waste collection units that operate autonomously, gathering waste from large oceanic regions. These units transfer the waste to the main ship, where it undergoes filtration and categorization into biodegradable and non-biodegradable components. Biodegradable waste can be processed into organic fertilizers or biofuels , while non-biodegradable waste is sent for recycling and repurposing . The proposed solution offers multiple benefits , including reducing ocean pollution, protecting marine biodiversity, and promoting a circular economy by recycling agricultural waste into valuable resources. Additionally, the integration of MRE technologies ensures an environmentally friendly and energy-efficient approach to waste management in marine environments. By combining advanced AI-powered waste detection, automated collection mechanisms, and renewable energy , this project provides a scalable and sustainable solution to address the pressing issue of agricultural waste pollution in the ocean. It supports global sustainability goals, ensuring cleaner oceans and a healthier planet for future generations.

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Experimental investigation of the hydrodynamic behaviour of the oscillating water column integrated with sea well

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Abstract:

Wave energy extraction is a valuable renewable energy resource with the potential to contribute significantly to sustainable energy solutions. Integrating wave energy devices with coastal structures like seawalls offers an innovative and sustainable solution by combining wave energy extraction with coastal protection. The performance of this integrated system in offshore areas is shaped by the distinct features of the coastline and the seawall design. The current research focuses on the integration of an Oscillating Water Column (OWC) device with a toe-protected seawall, aimed at optimizing wave power extraction while enhancing coastal protection. This innovative approach combines the energy-harvesting capabilities of the OWC with the wave attenuation properties of the seawall. A key aspect of this study involves the detailed analysis of hydrodynamic parameters such as wave pressure distribution, energy dissipation, and fluid-structure interactions. Understanding these parameters is crucial for evaluating the device's performance across varying ocean conditions and improving its operational efficiency. The results of this study could lead to advancements in hybrid coastal defence and renewable energy systems, promoting sustainable solutions for offshore and coastal regions.

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Harnessing Ocean Power: Advancements and Challenges in Tidal and Hydrokinetic Energy

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Abstract:

Tidal and hydrokinetic energy represent innovative renewable energy technologies that leverage the kinetic energy of ocean tides and currents to generate electricity. Tidal energy primarily exploits tidal movements through structures like tidal barrages—dams built across estuaries—and underwater tidal stream generators. Hydrokinetic energy, meanwhile, captures the consistent flow of ocean currents using submerged turbines. These technologies offer distinct advantages, including high energy density, predictability due to well-understood tidal patterns, minimal visual impact when submerged, and significant potential to reduce carbon emissions.

Despite their promise, challenges persist. High upfront installation and maintenance costs, coupled with technical hurdles such as durability in harsh marine environments, hinder widespread adoption. Environmental concerns, including potential disruptions to marine ecosystems and wildlife, require rigorous assessment. Furthermore, the location-specific nature of tidal energy limits deployment to regions with sufficient tidal ranges or strong ocean currents. Future advancements hinge on technological innovations to enhance turbine efficiency and material resilience, scaling up deployments through large-scale arrays, and fostering international collaboration to share expertise. Concurrently, comprehensive environmental monitoring is critical to mitigate ecological risks and ensure sustainable integration. As global interest in renewable energy grows, tidal and hydrokinetic systems could play a pivotal role in diversifying energy portfolios and advancing climate goals, provided economic, technical, and environmental challenges are addressed.

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Harnessing Tidal Energy for Sustainable Power Generation along the Andaman Islands, India

Mandar Bharat Gavali, Balaji Ramakrishnan
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Abstract:

Marine renewable energy offers a sustainable alternative for electricity generation, with tidal energy emerging as a particularly promising source due to its reliability and abundance. In India, the Andaman and Nicobar Islands currently rely predominantly on fossil-fuel-based power generation to meet their electricity demands, with diesel-based plants contributing the majority of the more than 100 MW cumulative capacity. The reliance on fuel transported from the mainland not only increases electricity production costs but also poses environmental challenges. Alternative renewable sources, such as hydro and solar power, contribute minimally to the region's energy mix. Given their extensive coastline of over 1,500 km, the Andaman and Nicobar Islands possess significant untapped ocean energy potential. This study aims to evaluate the tidal current energy resources in the region using advanced numerical modelling techniques. The objective is to generate comprehensive and visually intuitive maps of the tidal energy distribution, facilitating the identification of optimal locations for tidal power extraction. The dedicated numerical model is employed for this assessment and validated against available observational data, providing spatial and temporal insights into tidal energy availability and supporting informed decision-making for sustainable energy development in the region

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Blue Energy Revolution for Sustainable Power from Salinity Gradients

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Abstract:

The Blue Energy Revolution is all about tapping into a natural and sustainable energy source—salinity gradients, where freshwater and seawater meet. This project uses pressure retarded osmosis (PRO) and reverses electro dialysis (RED) membrane systems to convert this untapped energy into electricity. The process starts with freshwater and saltwater intake, followed by pre-treatment to remove any impurities before directing the saltwater to the membrane system. Here, the difference in salt concentration creates osmotic pressure, which is then converted into energy. To make the system more efficient, AI-driven optimization fine-tunes performance, and a hybrid integration approach combines blue energy with other renewable sources. The generated power is then processed, stored, and distributed through the grid system. This innovative approach not only provides a clean and renewable energy source but also reduces our reliance on fossil fuels. Scalable and adaptable, it offers a promising solution for coastal and estuarine regions, transforming the natural interaction of water into a practical, eco-friendly power solution for the future.

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Numerical Analysis of Savonius Turbine

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Abstract:

This article presents a numerical investigation of the Savonius hydrokinetic turbine (SHKT). It has simple construction and low cost of production. Previous research studies have demonstrated the effectiveness of SHKT in harnessing hydrokinetic energy. While various blade design parameters have been examined experimentally, gaining a comprehensive understanding of the turbine's transient performance and flow characteristics through experimentation remains challenging. To address this, a numerical model was developed based on existing experimental study to analyse the detailed transient performance and fluid flow behaviour. A two-dimensional numerical simulation was conducted using ANSYS Fluent 2019 R3. Pressure and fluid velocity distribution show the behaviour of fluid flow around the blade. The validated numerical model exhibited a maximum deviation of 6.31% from experimental values, excluding a tip speed ratio of 1.1

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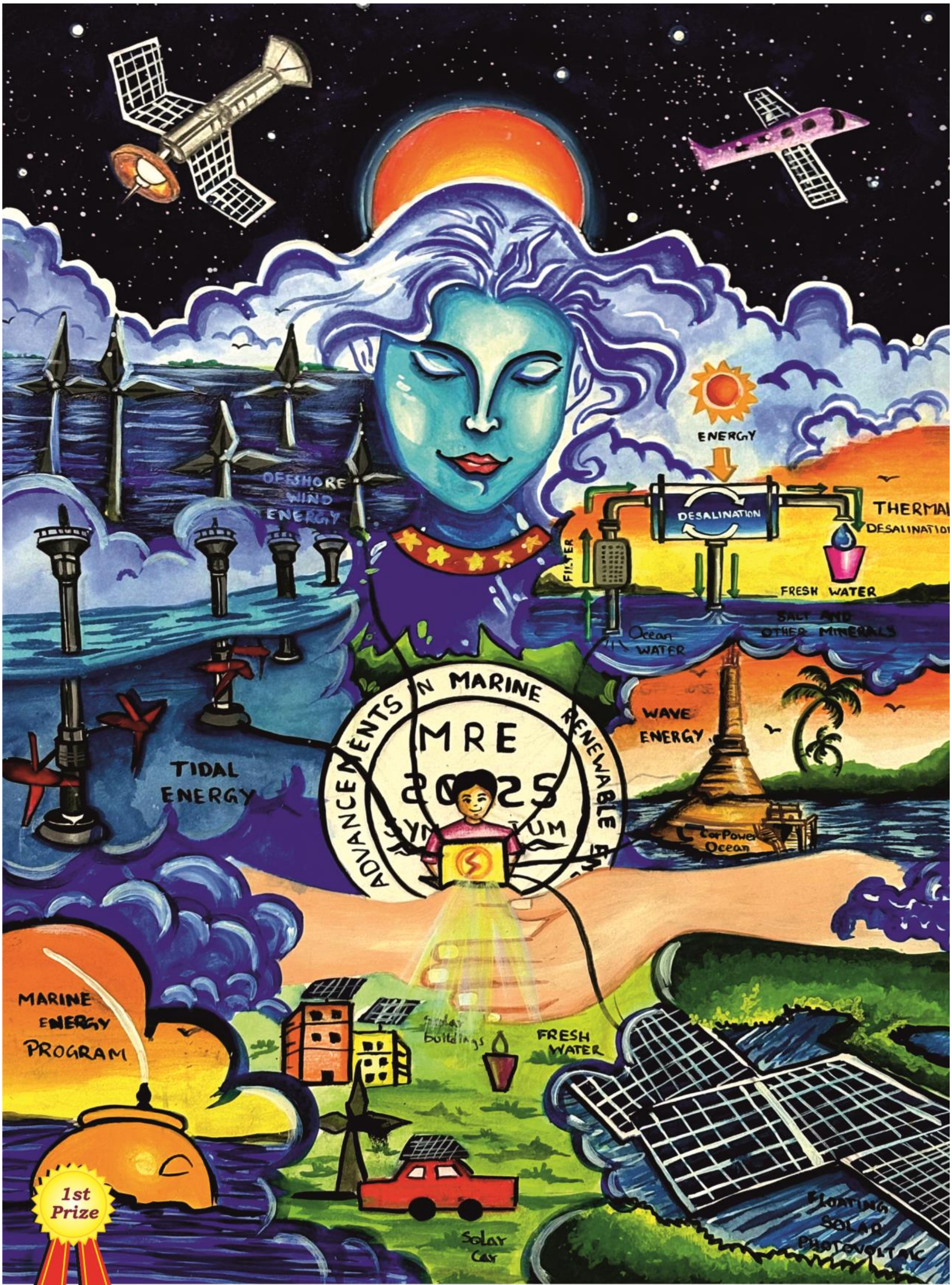
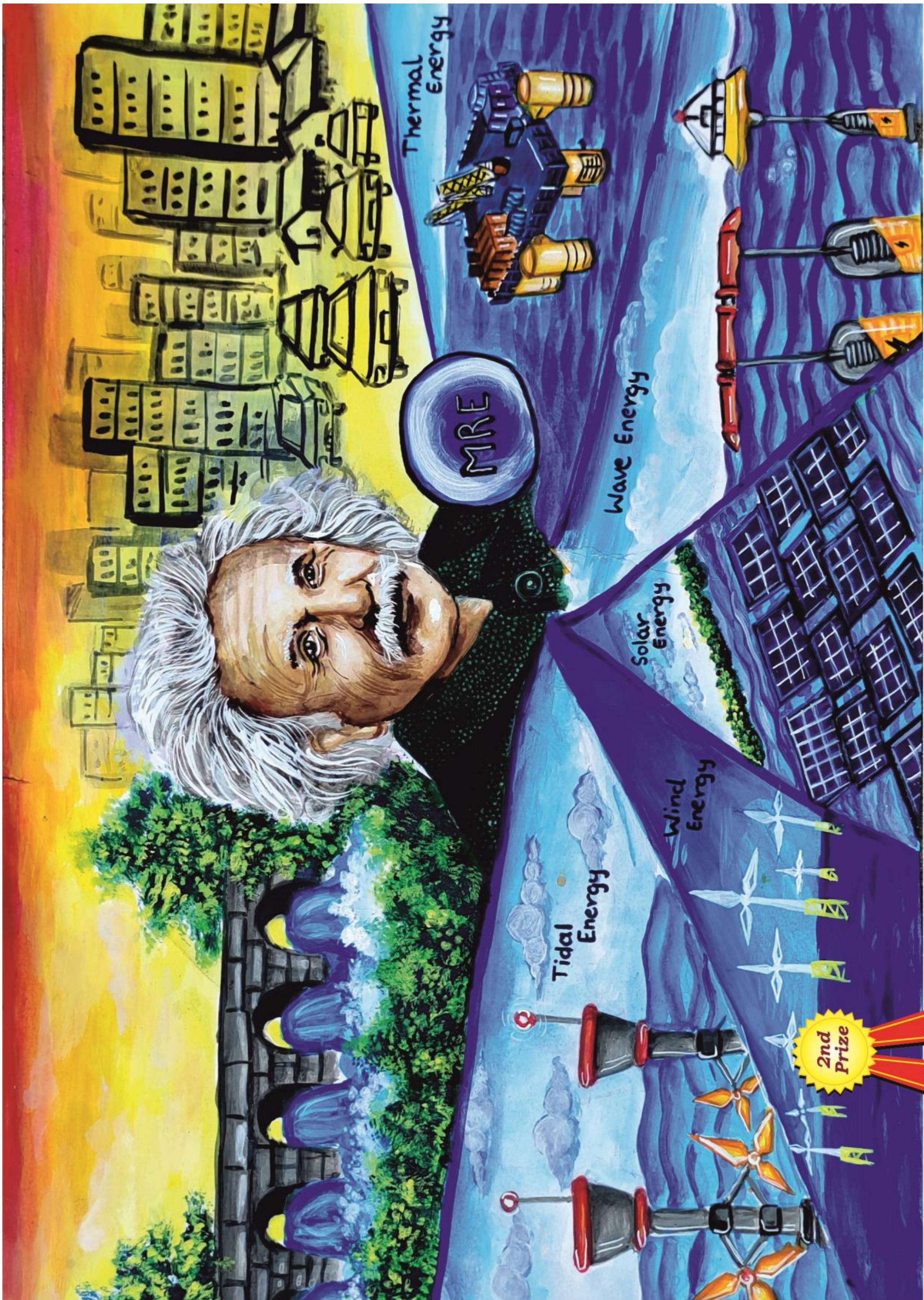
WINNERS
DRAWING COMPETITION
(8th – 12th CLASS)

Themes

1. Energy from Thermal Gradient
   i. OTEC
   ii. Thermal Desalination
2. Tidal/Hydrokinetic Energy
3. Wave Energy
4. Offshore Wind Energy
5. Floating Solar Photovoltaic
6. Energy from Salinity Gradient
7. Hydrogen from MRE sources
8. Standardization of Marine Energy Conversion Systems.
   i. IEC TC-114
   ii. BIS ETD-54

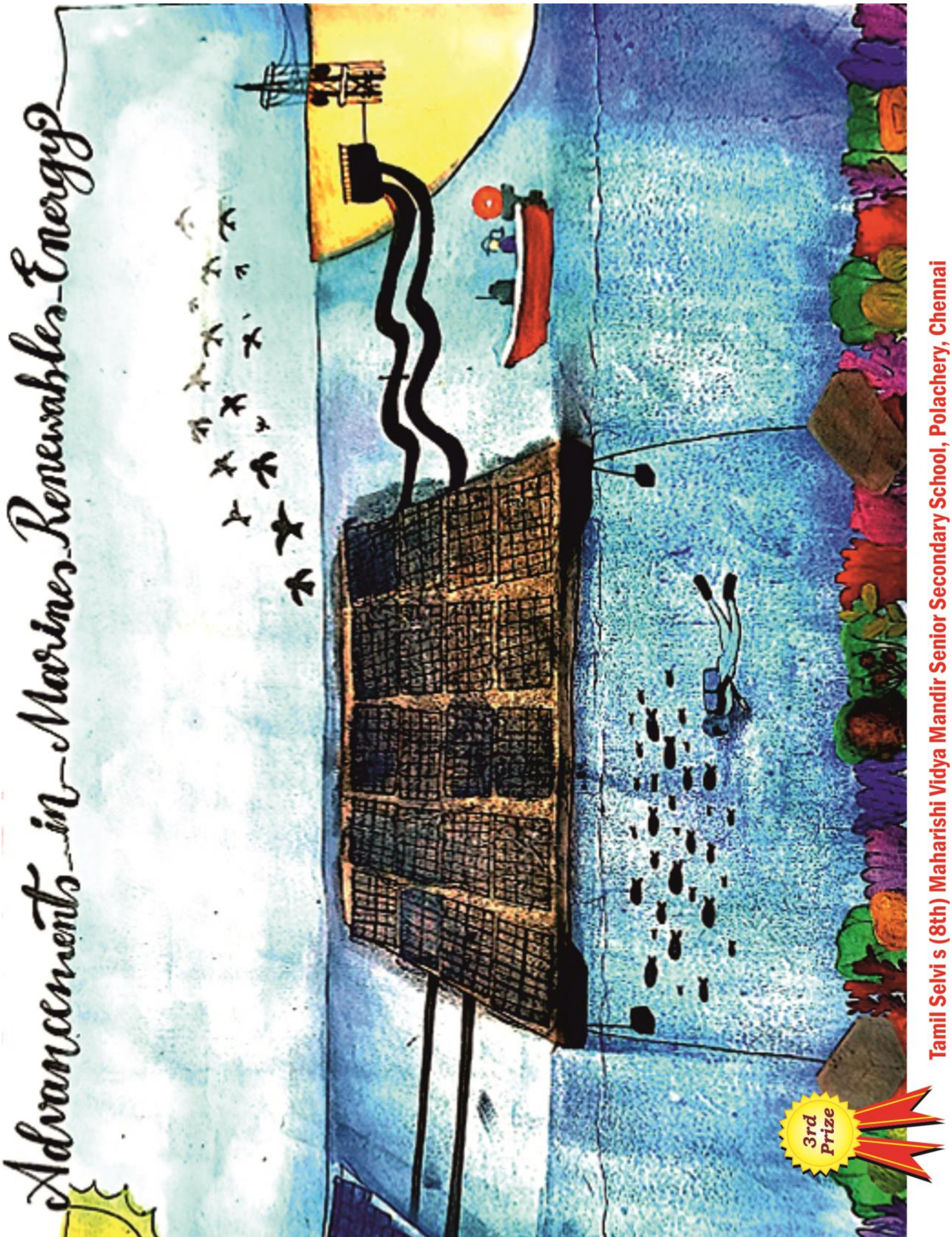


Bhavagnya Chalapareddi (8th) Sri Prakash Vidyaniketan, Vishakapatnam, Andhra Pradesh

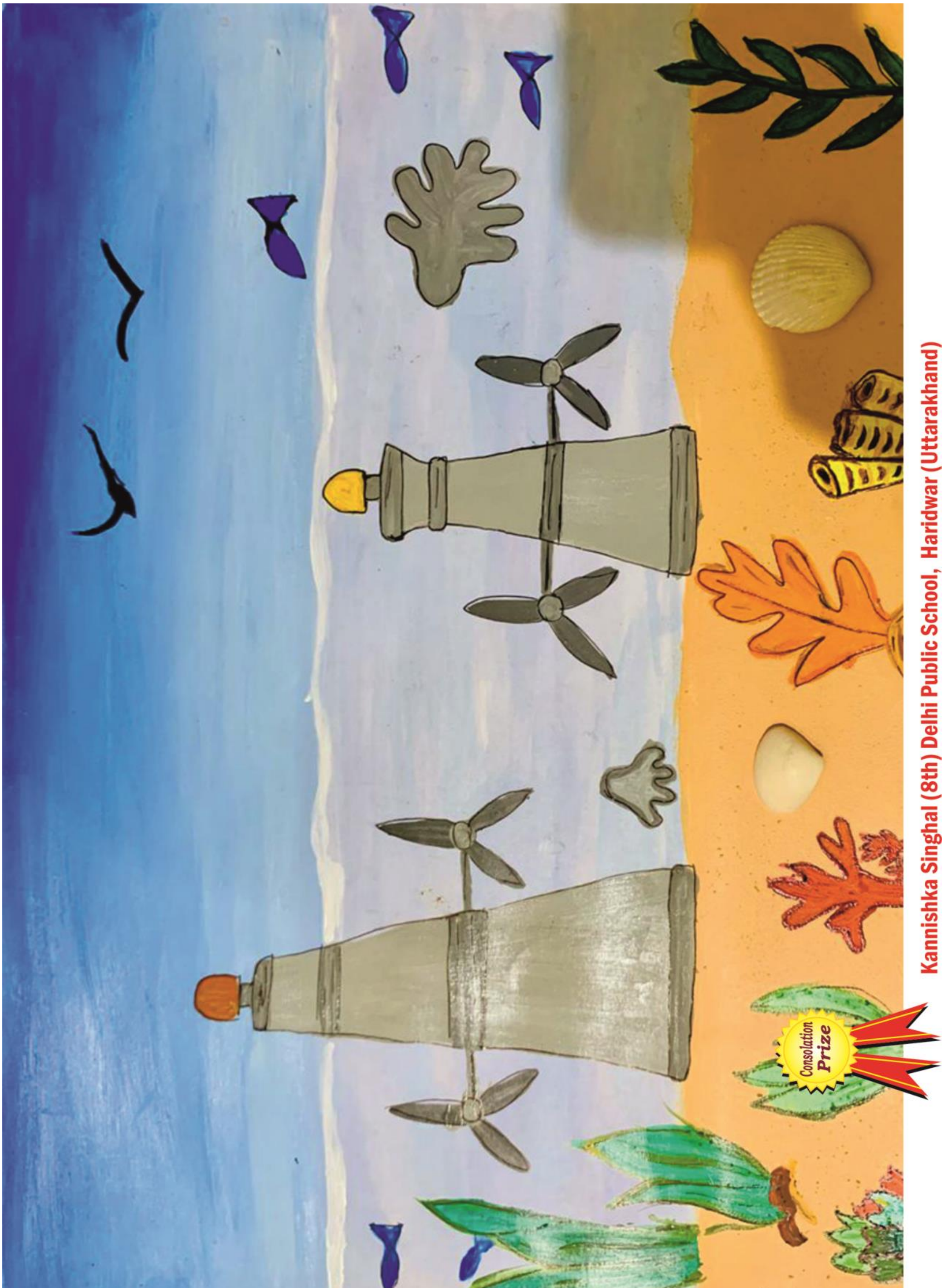


2nd Prize

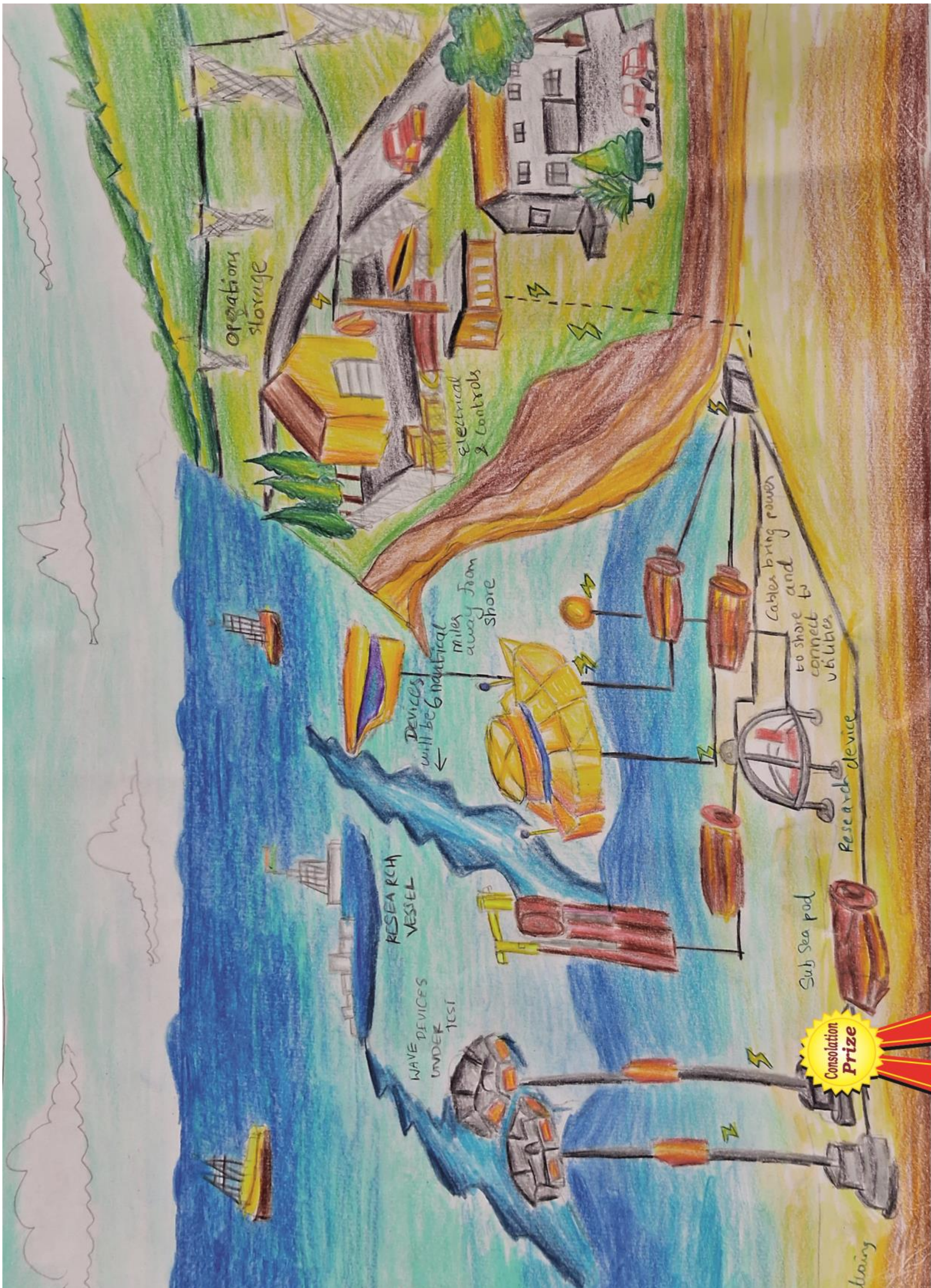
I.V.R LASYA (9th) Sri Prakash Vidyaniketan, Vishakapatnam, Andhra Pradesh



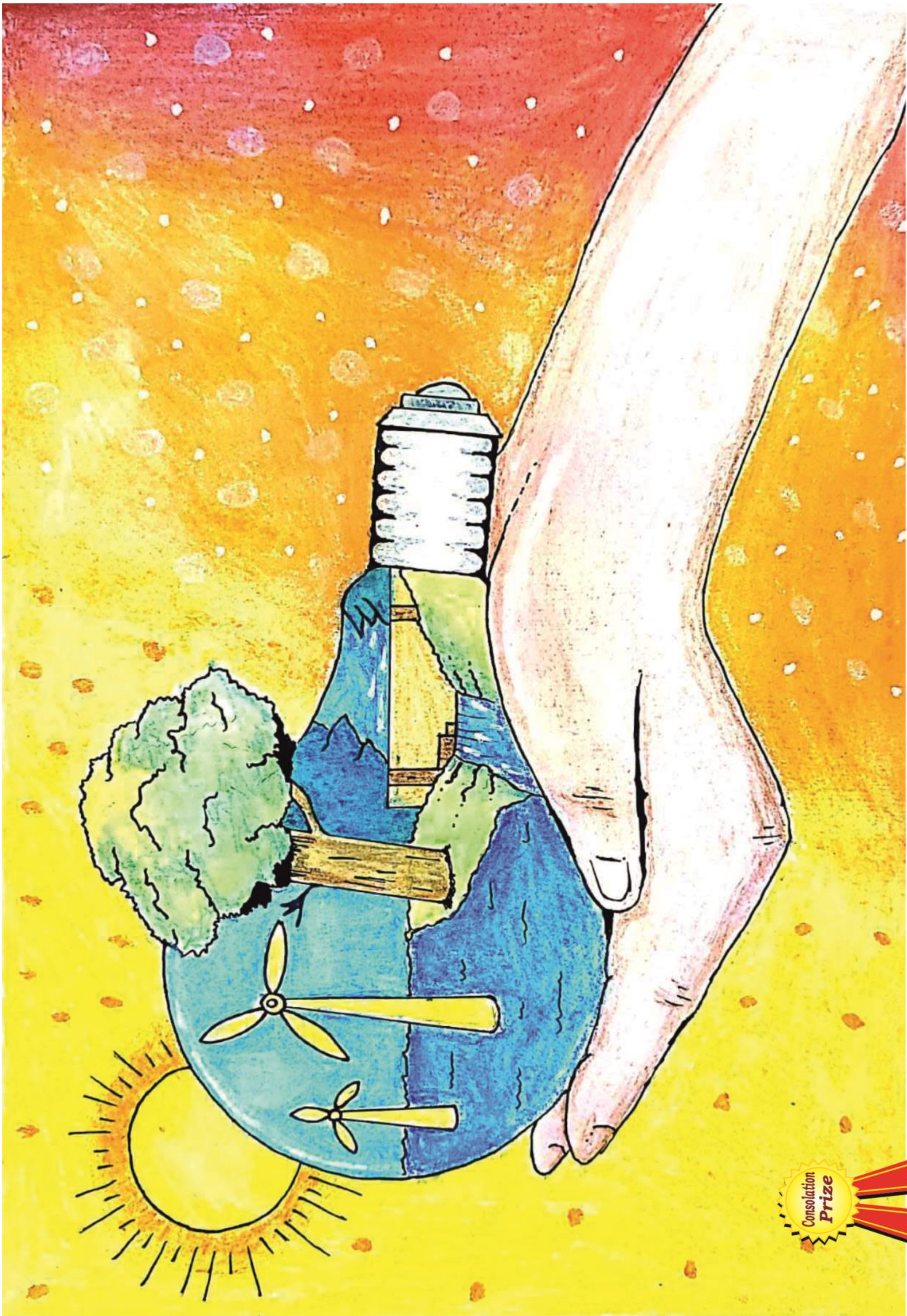
Tamil Selvi s (8th) Maharishi Vidya Mandir Senior Secondary School, Polachery, Chennai



Kannishka Singhal (8th) Delhi Public School, Haridwar (Uttarakhand)



P shivani (10th) Bharathi Vidyalaya senior secondary school



Consolation Prize

Jegathnarayan Jayakumar (12th) Maharishi Vidya Mandir Senior Secondary School, Polachery, Chennai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Organized by
Energy & Fresh Water Group
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