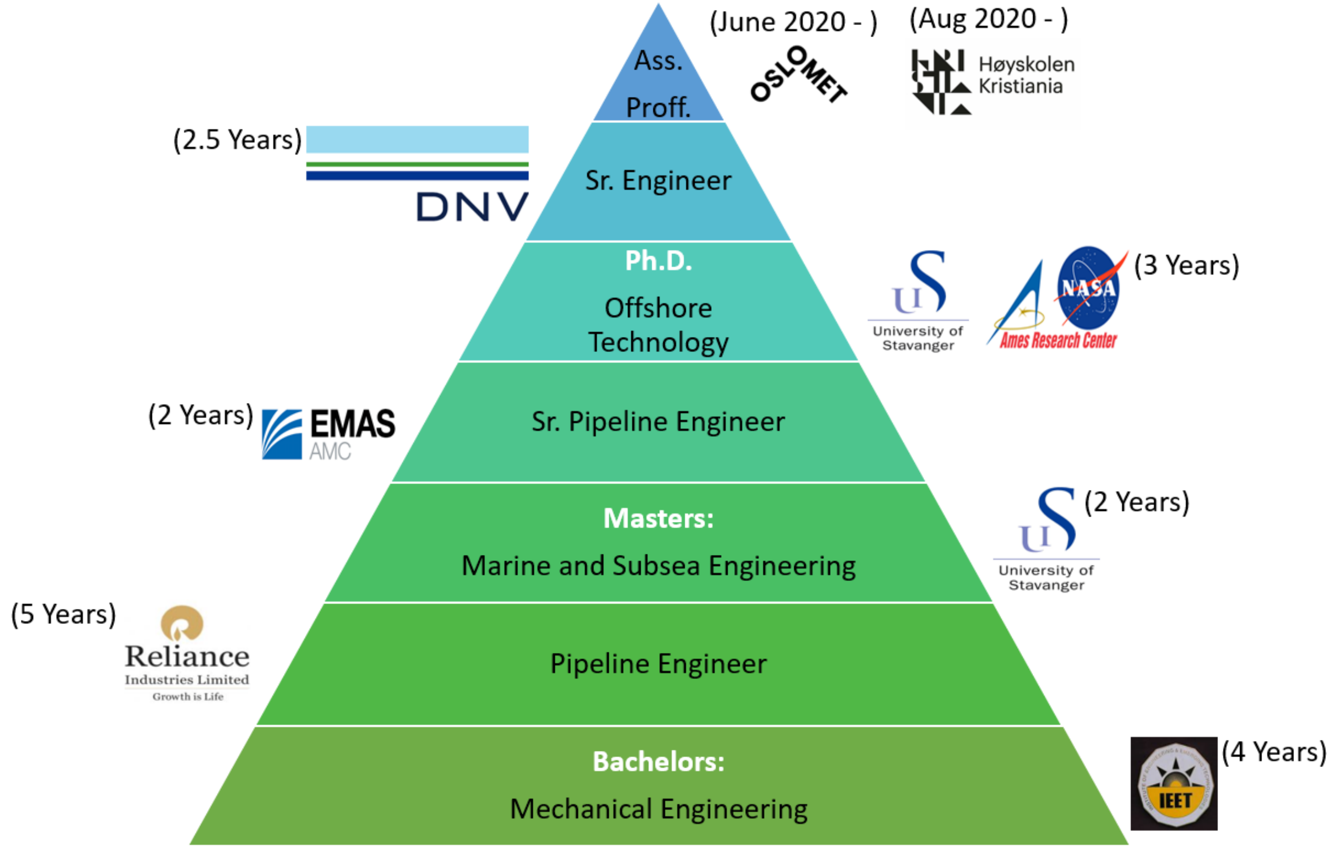


ARVIND KEPRATE

RESEARCH TALENT DEVELOPMENT PROGRAM, 2023

Contents for Today

- Vision and Goals.
- Career Plan (5 Years).
- Achieved in 2023.
- Value Gained From RTDP.

Research Vision

PHM EXPERT

Be the top researcher and academician within the domain of Prognostics and Health Management (PHM) of Socio-Ecological-Green-Energy-Technical Systems (SEGETS) and use my expertise to drive transformative advancements in sustainable engineering practices and policies.

Goals

How?

1. Strategy and Planning

A goal without a plan is just a wish.
- Antoine de Saint-Exupéry

2. Establishing Timeline

A goal is a dream with a deadline.
- Napolean Hill

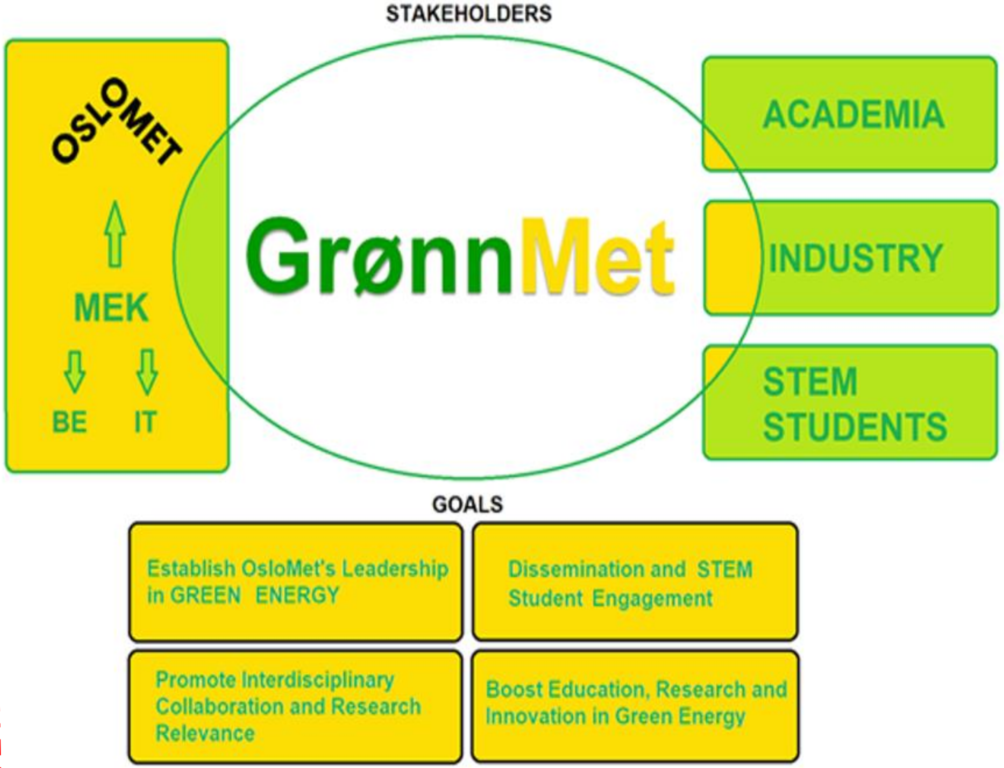
3. Creating a world class Network

Your network is your net worth
- Porter Gale

4. Motivation and Hardwork

The difference between a successful person and others is not a lack of strength, not a lack of knowledge, but rather a lack in will.
- Vince Lombardi

What?



Career Plan – 5 Years (2023-2027)

ROADMAP TO BE A PHM EXPERT

YEAR 2023

- Write proposal for ERC Starting Grant.
- Write 2 Journal and 4 conference articles henceforth.
- Complete online course about Wind Turbines (DTU).

YEAR 2024

- Write proposal for Young FRIPRO.
- Write proposal for MSCA Post Doc.
- Publish book on Probabilistic ML.
- Setup GrønnMet Lab at OsloMet.

YEAR 2025

- Develop online course on WF Prognostics for INTPART and UTFORSK.
- Apply for industrial PhD.
- Write proposal for MSCA Doctoral Network.

YEAR 2026

- Apply for KPN Projects.
- Organize a PHM conference at OsloMet.
- Hold workshop on Hybrid AI for Prognostics.

YEAR 2027

- Participate in industrial projects.
- Apply for MSCA Staff Exchange.
- Publish a book on PHM.

PhD Co-Supervision(2022-2027)

Time	PhD Title
2022-Present **NMBU, Norway**	Intelligent CFD Methods on Aerodynamic Flow in Offshore Wind Turbines Role: Contributing on topic of developing surrogate models using machine learning.
2023-Present **UiS, Norway**	Intelligent Application of Machine Learning to Enhance Asset Integrity Assessment and Control: Analyzing Human Factor Contribution for Accident Prevention and Mitigation. Role: Guidance related to build AI models for inspection planning using Human Factor and technical data.
2023-Present **IIT Mandi, India**	Structural Health Monitoring of Wind Turbines Role: Guidance on using deep learning for fatigue analysis of wind turbine towers.
2023-Present **OsloMet, Norway**	Global response analysis of modular floating solar farms in a marine environment. Role: Guidance on building metamodels for predicting wave response on solar farms.
2023-Present **OsloMet, Norway**	Manufacture of nanomaterials with application in Neuromorphic Computing. Role: Guidance related to generative AI for developing micro-surfaces.

Current Research Projects (WP Leader)(2022-2027)

Time	Project Description and Role	Funding Amount (NOK)
2023-2027	Work Package Leader for INTPART project Collaborative Research Based Education for Optimized Performance of Wind Farms. Role: Develop an online course and hold workshops on Wind Farm Predictive Maintenance.	10 mil
2023-2027	Work Package Leader for UTFORSK project EduWind (UTF-2021/10169). Role: Develop Micro-Course on Key Performance Metrics for Wind Farms.	3 mil
2023-2024	Develop an online course titled Probabilistic Machine Learning for Predicitve Maintenance of Energy Systems.	50k
2022-2023	Work Package Leader for project Virtual Sensors for Phosphorus and Carbon Balance in Continuous Flow MBBR EBPR process. Role: Employ AI to develop virtual sensors for the estimation of Phosphorus and Carbon in water treatment plants.	500k

The Research Council of Norway

Direktoratet for høyere utdanning og kompetanse

NORA.ai Norwegian Artificial Intelligence Research Consortium

REGIONALE FORSKNINGSFOND INNLANDET

Achieved During RTDP Year (Grants Submitted)

1. NORA (funded)

NORA.ai
Norwegian Artificial Intelligence
Research Consortium

Shortlisting of your course : Probabilistic Machine Learning for Predictive Maintenance of Energy Systems

SG Sachin Gaur <sachin.gaur@nora.ai>
To Arvind Keprate
Cc Klas Henning Pettersen

(i) This sender sachin.gaur@nora.ai is from outside your organization.

(i) You forwarded this message on 13-09-2023 11:52.

Suggested Meetings

Dear Arvind,

I am happy to inform you that your course has made it to the shortlist of NORA Call for Courses 2024 , to receive support of NORA Research School.

As we have already had discussions with you about the feedback of the board.

Let's plan a meeting together in the coming days for a smooth implementation. Can you propose your availability for the next week.

Thanks
-Sachin

2. OsloMet Strategic Funds

OSLOMET

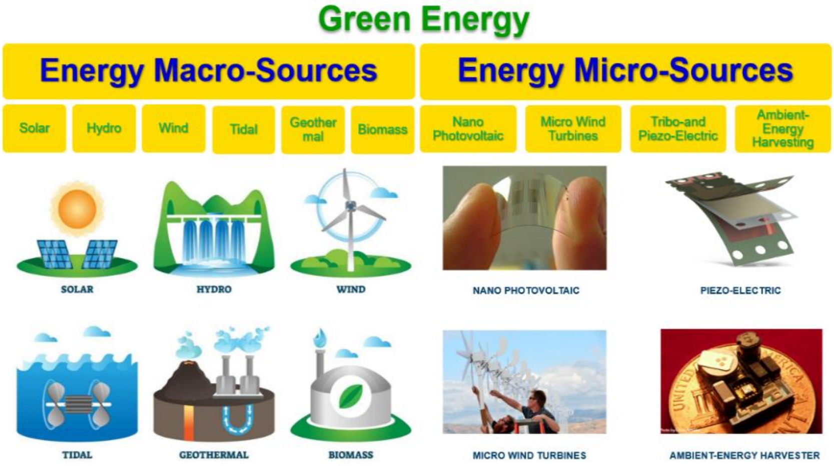
GrønnMet – OsloMet Green Energy Lab

Project Description

Project proposal, business case and project initiation document

Project owner/unit: Astrid Oust Janbu, TKD

Project Manager: Simen Antonsen, TKD



Achieved During RTDP Year (Grants Submitted)

3. EU Horizon

OFFWIND

European Commission

OFFWIND - The Disruptive Digital Twin Technology for Accurate and Precise Offshore Wind Farm Energy Yield Predictions for Europe

#@APP-FORM-HERIAIA@#

List of participants

Participant No.	Participant organisation name	Acronym	Country
1 (Coordinator)	The University of Iceland (Coordinator)	UOI	IS
2	Forschungszentrum Juelich GmbH	JUELICH	DE
3	CERFACS	CERFACS	FR
4	Norwegian University of Science and Technology	NTNU	NO
5	Technical University of Denmark	DTU	DK
6	Consensus	CONS	SI
7	Eles	ELES	SI
8	University of Ljubljana	UOL	SI
9	Akvaplan-niva/NIVA	NIVA	NO
10	Oslomet University	OSMET	NO
11	AUDNA Technology Transfer Office	AUDNA	IS

4. ERC-Starting Grant

erc European Research Council
Established by the European Commission

ERC Starting Grant 2024
Research proposal [Part B1]

Novel Interdisciplinary Prognostics and Health Management Framework for Wind Farms

PROGWIN

Cover Page:
- Name of the Principal Investigator (PI): Arvind Keprate
- List the other PI's Host Institution for the project: Oslo Metropolitan University, Norway
- Proposal duration in months: 60 months

According to the International Renewable Energy Agency, wind energy could supply 20% of global electricity by 2030. However, the social acceptance and ecological impact of wind farms (WFs) remain significant barrier to realize this vision. Typically viewed as purely technical entities, WFs' siting, operation, and maintenance (O&M) have significant socio-ecological implications. Standard practices involve Social & Ecological Impact Assessments during the siting phase, but O&M plans generated by current Prognostics and Health Management (PHM) frameworks often neglect societal sustainability. These frameworks are designed for isolated technical systems, not Socio-Ecological-Technical Systems (SETS) that WFs truly are.

To bridge this gap, PROGWIN aims to redefine status quo in PHM domain, by executing 4 iterative stages (ST). ST1 focuses on collecting relevant data from diverse sources (society, ecology, technical) and preprocessing it using approaches such as Qualitative Mathematical Modeling and Deep Learning to extract key features. In ST2, cleaned data and key features from ST1 are used to develop diagnostic and prognostic Bayesian Network (BN) model that captures system-level dynamics (spatial and temporal) of WFs. In ST3, novel PHM framework driven by BN model from ST2, is developed and evaluated using maturity models to ensure continuous improvement and alignment with stakeholder input. ST4 culminates in the development of prescriptive & dissemination toolkit, leveraging Influence Diagrams and Reinforcement Learning to devise O&M policies that meet social expectations and technical excellence. This stage also includes rigorous testing and validation of proposed framework and toolkit with real-world data.

Leveraging the PI's industrial experience and expertise within O&M, prognostics, data analytics, ML, and BN modeling, PROGWIN aspires to radically transform the PHM of WFs, by ensuring sustainable coexistence of their societal, ecological, and technical elements.

Achieved During RTDP Year (Papers Published)

6 Conference Papers.

Limitations and Opportunities in PHM for Offshore Wind Farms: A Socio-Technical-Ecological System Perspective

Arvind Keprate[1]

[1]*Department of Mechanical, Electronics and Chemical Engineering, Oslo Metropolitan University, Oslo, 0167, Norway*
arvind.keprate@oslomet.no

ABSTRACT

The burgeoning importance of offshore wind farms (OWFs) in the transition to sustainable energy systems underscores the need for effective Prognostics and Health Management (PHM) strategies. While the current PHM framework demonstrates its prowess in enhancing the reliability and operational efficiency of OWFs, this paper contends that its potential remains largely untapped due to certain inherent limitations. This study casts a comprehensive spotlight on the limitations and untapped opportunities within the PHM framework for OWFs from a Socio-Technical-Ecological Systems (SETS) perspective.

The limitations, as identified, are threefold. First, the existing framework exhibits an over-reliance on technical factors, thus prioritizing maximization of Remaining Useful Life and cost minimization. This emphasis disregards crucial Non-Technological Factors (such as community impacts, stakeholder engagement, Human and Organization Factors (HOFs)) and uncertainty arising from them, which can exert significant influences on OWF's health and performance. Second, the PHM approach often adopts a component-centric view, with focus on dominant degradation modes, thus undermining the intricate interdependencies among diverse components and failure modes. This lack of a System Level Perspective (SLP) and Multi-Modal Degradation (MMD) hampers a comprehensive understanding of how component degradation cascades through the entire system. Third, the current framework largely ignores the ecological considerations, despite compelling evidence that the current monitoring, assessment, and maintenance activities has significant ecological consequences.

By addressing the identified limitations and leveraging the opportunities together with AI, the PHM framework for OWFs can evolve into a more comprehensive, inclusive, and resilient approach. The proposed paradigm shift resonates deeply with the contemporary drive towards sustainability, not only in terms of technical efficacy but also in terms of social acceptance and ecological compatibility.

1. INTRODUCTION

Offshore wind energy has a huge potential as an alternative to fossil fuels in regard to decarbonizing, mitigating greenhouse gas emissions (International Energy Agency, (2019)) and contributing to achieving the United Nations SDG#7 "affordable and clean energy" & SDG#13 "climate action" (United Nations, (2016)). With an annual electricity generation capacity of 12GW from offshore wind farms (OWFs), the European Union (EU) leads the tally and has plans to ramp up the generation to 60GW by 2030 and 300GW by 2050 for a climate-neutral future (European Commission, (2020)). Norway's ambitions align with that of the EU, as the target is to generate 30GW by operating 1500 offshore wind turbines (WTs) within 2040 (Norwegian Government, (2022)). Ongoing development of Hywind Tampen (Equinor, (2022)) followed by tendering of Sørlige Nordsjø II and Utsira Nord (Norwegian Government, (2022)) marks the first step in this direction.

To remain economically attractive for investors and consumers, it is vital to decrease the levelized cost of energy from OWFs (Mai, Lantz, Mowers, & Wiser (2017)). In order to achieve these significant technical developments have been made in blade, drivetrain and foundation design of WTs (IRENA, (2019)), however still challenges related to system dynamics, optimization and control of wind farms are being actively researched (Clifton, A., Barber, S., Bray, A., Enevoldsen, P., Fields, J., Sempreviva, A. M., Williams, L., Quick, J., Purdue, M., Totaro, P., & Ding, Y. (2023)). Another approach of reducing LCoE, is to increase availability of wind turbines 24/7, by optimal O&M activities, as it can account up to 35% of running cost of the OWFs (Sarker, B. R., & Faiz, T. I. (2016). This is achieved due to the timely inspection and maintenance (I&M) based

phmsociety conferences

2 Book Chapters.

Key Components of the Horizontal Axis Wind Turbine

Nikhil Bagalkot[1], Jithin Jose[2] , Arvind Keprate[1]

[1]Department of Mechanical, Electronics and Chemical Engineering, Oslo Metropolitan University, Norway

[2]Multiconsult, Stavanger, Norway

Abstract

Due to the growing energy demands, and reliance on clean energy concepts, wind energy is one of the fastest growing energy sources in the world. A wind turbine is used to harness the kinetic energy of the wind to generate electricity. Spate number of wind turbine designs such as Horizontal Axis Wind Turbine (HAWT), Vertical Axis Wind Turbine (VAWT), Cross Axis Wind Turbine (CAWT), Wind Tree, Vortex Bladeless, Kitemill etc. are available in the market today. Amongst the designs, HAWT is widely acceptable concept due to its stability and high efficiency. This chapter discusses the various components such as rotors, towers, drivetrains, support structure of a typical HAWT. Detailed discussion about the structure of the composite rotor is presented. Thereafter, short notes about pitch and yaw control systems is made. Afterwards, the design of tower and different support structures is presented which is followed by summarizing the drive trains of HAWT.

Keywords

Horizontal Axis Wind Turbine, Rotor, Tower, Control system, Support Structure, Drivetrain

1. Introduction

The need of boosting alternative renewable energy sources to reduce the dependency on conventional fossil fuel dependency has become an important global issue. The need and urgency for alternative energy resources have been further emphasized by Horowitz [1] entered into force in November 2016. Simões-Filho [2] claims that renewables are supposed to contribute to half of the additional energy of 30% that will be added by the year 2035. To achieve this number, renewable energy production, in the particular generation of energy from wind power using wind turbines (WT), has seen remarkable growth as wind energy has high potential and better cost benefits [3]. Industry experts predict that in the coming years countries like the U.S., China, and some of the European Union countries have planned to increase the contribution of the wind energy share to their energy demand to about 20% [4].

3 Journal Papers.

ELSEVIER

Ocean Engineering
Volume 288, Part 2, 15 November 2023, 116138

Reliability analysis of 15MW horizontal axis wind turbine rotor blades using fluid-structure interaction simulation and adaptive kriging model

Arvind Keprate [a], Nikhil Bagalkot [b], Muhammad Salman Siddiqui [c], Subhamoy Sen [d]

Show more

https://doi.org/10.1016/j.oceaneng.2023.116138

Journal of Physics: Conference Series

PAPER • OPEN ACCESS

Effect of leading-edge erosion on the performance of offshore horizontal axis wind turbine using BEM method

H H Mian[1], M S Siddiqui[1], L Yang[2], A Keprate[3] and A W Badar[4]

Published under licence by IOP Publishing Ltd
Journal of Physics: Conference Series, Volume 2626, EERA DeepWind conference 2023 18/01/2023 - 20/01/2023 Trondheim, Norway
Citation H H Mian *et al* 2023 *J. Phys.: Conf. Ser.* **2626** 012028
DOI 10.1088/1742-6596/2626/1/012028

Network Building (2023)

Signe Riemer-Sørensen

Stine Skaufel Kilskar

SINTEF Digital

NREL
Transforming ENERGY

Shawn Sheng

Eleni Chatzi

ETH zürich

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Juan Chiachio

Ravi Rajan

UNIVERSITY OF CALIFORNIA
SANTA CRUZ

Tangible Benefits: Personality Evaluation

B5-PLUS is Human Contents personality inventory, based on the internationally renowned "Big Five" model

3 Profiles:
Research Group Leader

Communication, Financing, Promoting

Researcher: Independent Work

→

Research Group Leader:
Mechanics, Mechatronics & Material Technology (M3T) Research Group

Tangible Benefits: Marketing and Online Presence

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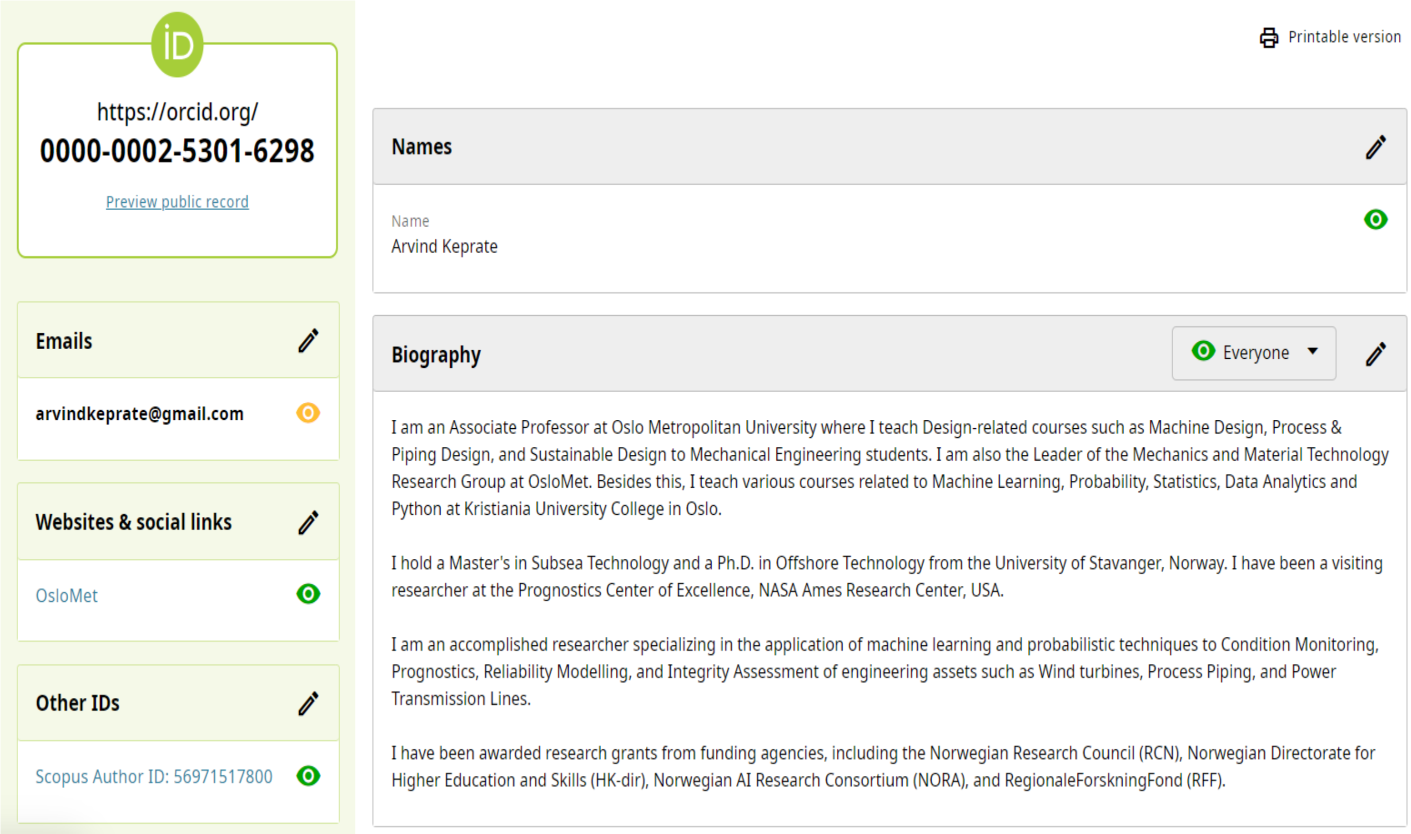

Non-Tangible Benefits: From Heart

Thank You for Attention

Google Scholar Profile

Arvind Keprate

Associate Professor (OsloMet University)
Verified email at oslomet.no - Homepage

Fatigue&Fracture   Prognostics&Diagnostics   Wind Turbines   Digital Twin

FOLLOW

TITLE	CITED BY	YEAR
Enhancing offshore process safety by selecting fatigue critical piping locations for inspection using Fuzzy-AHP based approach A Keprate, RMC Ratnayake Process Safety and Environmental Protection 102 (2016), 71-84	61	2016
Adaptive Gaussian process regression as an alternative to FEM for prediction of stress intensity factor to assess fatigue degradation in offshore pipeline A Keprate, RMC Ratnayake, S Sankararaman International Journal of Pressure Vessels and Piping	40	2017
Minimizing hydrocarbon release from offshore piping by performing probabilistic fatigue life assessment A Keprate, RMC Ratnayake, S Sankararaman Process Safety and Environmental Protection 106, 34-51	33	2017
Probability of detection as a metric for quantifying NDE capability: the state of the art A Keprate, RMC Ratnayake J. Pipeline Eng 14 (3), 199-209	31	2015

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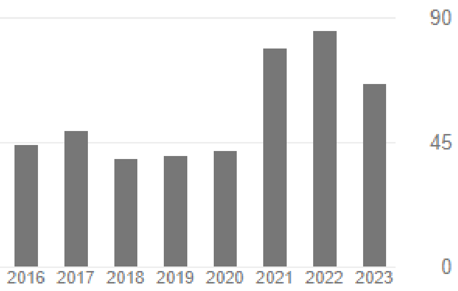
i10-index	16	11



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