NATIONAL TECHNICAL UNIVERSITY OF ATHENS
PROFESSIONAL INTERDISCIPLINARY POSTGRADUATE PROGRAMME OF SPECIALIZED STUDIES
«Infrastructure and Construction Project Management»

Postgraduate Diploma Thesis

Machine Learning-Based Wind Forecasting for Infrastrure Management: A Case Study on Plagia Psiloma Wind Farm

Student Name: ***Flora Ioannidi***

Supervisor: ***Nikolaos Lagaros, Professor, NTUA***

Date: ***October 2025***

Abstract

Infrastructure constitutes a fundamental pillar of societies, demanding robust management, while wind energy has become one of the most rapidly expanding renewable resources. In parallel, machine learning (ML) has advanced considerably, offering powerful approaches for analyzing complex datasets and enabling data-driven decision-making. Bringing these perspectives together, this thesis unites these domains by applying ML-based wind forecasting to the management of wind energy infrastructure.

The study investigates the extent to which ML models can deliver accurate short-term wind speed forecasts and how such predictions can be incorporated into management processes. The goal is not only to assess forecasting performance, but also to demonstrate its potential to support operational decisions.

The methodology involved collecting and processing SCADA data from the Plagia–Psiloma wind farm and implementing three ML models: Long Short-Term Memory (LSTM), Neural Hierarchical Interpolation for Time Series (N-HiTS), and D-Linear. In addition, a Decision Support Tool (DST) was developed to operationalize the forecasts by providing actionable recommendations, supporting decision-making, and maintaining a record of historical data.

The results show that while all three models produced viable forecasts, LSTM and N-HiTS achieved higher accuracy (RMSE ≈ 1.56), whereas D-Linear, although computationally efficient, displayed reduced precision (RMSE = 1.66). The DST complements these outcomes by enabling the integration of forecasts into a practical environment where they can inform decision-making processes.

In conclusion, this thesis demonstrates how ML forecasting techniques can be connected to infrastructure management, providing wind farm operators with more informed, data-driven decisions and potentially offering benefits in terms of efficiency and reduced downtime.

Keywords: wind speed forecasting, machine learning, LSTM, N-HiTS, D-Linear, SCADA, decision support tool,infrastructure management.

WITH SUPPORT AND EXCLUSIVE FUNDING OF ΓΕΚ ΤΕΡΝΑ ΟΜΙΛΟΣ ΕΤΑΙΡΕΙΩΝ