COMPARATIVE MODELLING OF SMALL WIND TURBINE SYSTEMS USING MATLAB/SIMULINK BASED ON VARIOUS POWER COEFFICIENT MODELS IN KUPANG-INDONESIA

Final Project Report

Nicholas Pranata

00000054176

ENGINEERING PHYSICS STUDY PROGRAM

FACULTY OF ENGINEERING AND INFORMATICS

UNIVERSITAS MULTIMEDIA NUSANTARA

TANGERANG

2025

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Final Project Report

Proposed to Fulfill one of the requirements
to obtain the title of
Bachelor's of Engineering Physics

Nicholas Pranata

00000054176

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2025

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Full Name	: Nicholas Pranata
Student ID	: 00000054176
Study Program	: Engineering Physics
Faculty	: Engineering and Informatic

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with the order of examiners as follows

Examiner

Assoc. Prof. Ir. Arko Djajadi, M.Sc.EE, Ph.D.
0406086704

Advisor

Fahmy Rinanda Saputri, S.T., M.Eng.
0326089301

Head of Engineering Physics

Muhammad Salehuddin, S.T., M.T.
0306108702

APPROVAL OF PUBLICATION

I hereby,

Full Name : Nicholas Pranata

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PREFACE

With all the praise and thanks to Almighty God who has given his love and mercy so that the thesis titled “Comparative Modelling and Simulation of Small Wind Turbine Systems Using MATLAB/Simulink Based on Various Power Coefficient Approaches in Kupang-Indonesia” can be finished well. This thesis is written as the requirement to obtain the title of Bachelor of Engineering Physics. It is undoubted that without the support and help from related parties, this paper would not be done.

I would like to thank

1. Dr. Ninok Leksono, M.A., as the Rector of Universitas Multimedia Nusantara.
2. Dr. Eng. Niki Prastomo, S.T., M.Sc., as the Dean of the Faculty of Universitas Multimedia Nusantara.
3. Muhammad Salehuddin, S.T., M.T., as the Head of the Study Program of Universitas Multimedia Nusantara.
4. Fahmy Rinanda Saputri, S.T., M.Eng., as the first Advisor who has provided guidance, direction, and motivation for the completion of this report.
5. My family and friends have provided material and moral support, so that I can complete this thesis.

Tangerang Regency, 23 April 2025

Nicholas Pranata

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Nicholas Pranata

ABSTRAK

Dengan berkurangnya cadangan bahan bakar fosil dan dampak lingkungan yang ditimbulkannya, seperti perubahan iklim, kebutuhan akan energi, terutama listrik, terus meningkat. Oleh karena itu, penggunaan energi terbarukan perlu segera diwujudkan. Salah satu sumber energi yang tersedia secara luas di berbagai belahan dunia adalah energi angin. Di Indonesia, energi ini bisa diterapkan di Kupang, Nusa Tenggara Timur, mengingat potensinya yang tinggi untuk mengatasi krisis listrik dan seringnya terjadi pemadaman. Penelitian ini bertujuan untuk memodelkan dan membandingkan kinerja turbin angin kecil berdasarkan pendekatan matematika koefisien daya, termasuk polinomial, sinusoidal, dan eksponensial dengan menggunakan MATLAB/Simulink. Dari hasil penelitian ditemukan bahwa model Ovando et al., dengan koefisien 0,4513, menghasilkan daya antara 9000 hingga 16000 W dengan asumsi kecepatan angin berkisar 50 sampai 60 km/jam. Analisis ini mempertimbangkan parameter seperti jari-jari bilah 2 m, rasio kecepatan ujung (λ) sebesar 7, sudut pitch (β) 0 derajat, dan kepadatan udara 1,225 kg/m³. Temuan ini dapat berkontribusi pada solusi krisis listrik di Kupang dan membantu mencapai target energi terbarukan sebesar 23% pada tahun 2025.

Kata kunci: *energi terbarukan, sistem turbin angin kecil, Kupang, MATLAB/Simulink, model matematis koefisien daya, listrik*

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ABSTRACT

With the rapid depletion of fossil fuels that cause environmental impact such as climate change while the need for energy, especially electricity, is increasing in demand, the use of renewable energy must be immediately executed. One of the types available in most parts of the world is wind energy. In Indonesia, this energy can be implemented in Kupang, Nusa Tenggara Timur due to its high potential in which in contrast, has faced electricity crisis and frequent blackouts. Thus, this research aims to models and compares small wind turbines based on existing power coefficient mathematical approaches which are polynomial, sinusoidal, and exponential using MATLAB/Simulink. The result of this study is based on the selected model, which is the Ovando et al. model with a coefficient of 0.4513. This model produced power in the range of 9000–16000 W under the assumption of periodic wind speeds of 50–60 km/h. The calculations were based on pre-determined parameters, including a blade radius of 2 m, a tip speed ratio (λ) of 7, a pitch angle (β) of 0 degree, and an air density of 1.225 kg/m³. The output may help in solving Kupang's electricity issues and reach 23% of renewable energy target by 2025.

***Keywords**: renewable energy, small wind turbine system, Kupang, MATLAB/Simulink, power coefficient mathematical model*