MINISTRY OF INDUSTRY AND TRADE
ELECTRIC POWER UNIVERSITY

SOCIALIST REPUBLIC OF VIET NAM
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INFORMATION ON NEW CONCLUSIONS OF DOCTORAL DISSERTATION

(Information will be posted on the Website)

Name of dissertation: *Proposed models for designing wind turbine blades and installed configurations of onshore wind farms in Vietnam*
Major: Energy Engineering. Code No: Pilot
Name of PhD. Student: Dinh Van Thin
Advisors: 1. Assoc. Prof. Dr. Nguyen Huu Duc
2. Dr. Le Quang Sang
Training Institution: Electric Power University

Summary of new contributions of the Dissertation

1. General conclusion: The thesis has conducted research and proposed two models for designing turbine blade profiles and turbine installation configurations for onshore wind farms. These models include three main parts: determining locations with high wind energy potential, turbine blade profiles for the largest power coefficient, and installation configurations for the largest annual electricity production. These design models include both analytical theory and numerical simulation methods. These theories help determine the relationship between the quantities describing the operation of wind turbines. The simulation models help calibrate the values of wind speed, turbulence intensity, wind speed frequency, and wind direction at locations in the wind farm development area. These models are very suitable and can be widely applied to actual conditions in Vietnam. In addition, the boundary conditions of the design models are terrain conditions, and the initial conditions are wind resource characteristics. Therefore, these design models only need wind resource data measured at one location in the farm area. Then, the entire processes of movement, interaction and transformation of wind resource characteristics according to the terrain will be accurately described by the GIS - CFD model. From there, some hypothetical risk analysis cases under extreme weather conditions can also be easily identified, helping to minimize problems related to incidents and accidents throughout the life of the turbines. This is a great advantage of the model compared to other design models. The design models proposed in this thesis are highly effective and intuitive. However, the participating models such as GIS and CFD are modern big data models. To use these tools, a computer system with a large enough configuration is required and the person performing these analyses must have sufficient knowledge and experience, especially experience in selecting the type of grid, meshing, choosing the solver, and turbulence modeling in CFD models.

2. Scientific and technical issues solved: The thesis has built 2 design models, respectively, the turbine blade profile design and the turbine installation configuration design in onshore wind farms.

• The blade profile design model has solved the scientific problem of providing steps for design, analysis, evaluation and selection of the turbine blade design for the highest wind energy exploitation efficiency in the wind speed range from 4.0 m/s to 6.0 m/s. In particular, the parameters of the CFD simulation model proposed in this thesis have made significant scientific contributions because this model gives aerodynamic analysis results for the blade model with high accuracy, about 3%. This model was then applied to a number of wind turbine blade models and created new blade designs for high wind energy exploitation efficiency of up to 50.5% under operating conditions with common wind speeds in Vietnam.

• The design model of the installation configuration of turbines in onshore wind farms has solved a complex technical problem in the wind power field. This model simultaneously combines analytical theoretical models, geographic information data and computational fluid dynamics simulation. This design model has simultaneously considered many complex factors such as terrain, wind resource, turbine type. From there, the configuration of turbines installed in the farm for the highest annual electricity production is determined. This is a very complex technical problem and has been clearly and intuitively solved through the design model proposed in this thesis. This model was then applied to a wind farm in the former Ninh Thuan province (now Khanh Hoa province). The results showed that the turbines in the farm were not installed properly. After using the design model, 10 turbines were installed in the new configuration for an increase of 4.2% in annual electricity production. In addition, this farm area has a large land area. To make the most of the land area of this area, a new turbine installation configuration has been proposed. This new installation configuration allows for the installation of 30 turbines and the annual electricity production from this farm area can be increased by about 2.5 times.

3. Scientific and practical significance: Currently, countries around the world are making efforts to transition to energy to reduce greenhouse gas emissions and prevent environmental change. Vietnam is also developing onshore and offshore wind power projects to achieve the goal of achieving net-zero emissions by 2050. The two design models proposed in this thesis have great significance in both science and practice.

• Scientific significance: This thesis studies and proposes optimal models for designing turbine blade profiles and turbine installation configurations in an onshore wind farm based on the combination of BEM, Jensen theories and modern simulation models such as GIS and CFD. GIS models use large spatial data sources, allowing accurate determination of terrain characteristics. CFD models are very

modern analysis and simulation tools. Building highly accurate CFD models has great scientific significance.

• Practical significance: Vietnam is developing renewable energy. In which, wind power will contribute a large proportion to the power source structure in the coming time. Currently, Vietnam is in the process of implementing many onshore and offshore wind power projects. This thesis provides a design model of turbine blade profile and installation configuration of onshore wind turbines. These design models can contribute to the operational and investment efficiency of onshore wind power projects in Vietnam. Therefore, this thesis has high practical significance. In addition, the results of this thesis have also shown that domestic scientists can participate in the development stages of wind power projects in general, affirming the technological mastery, reducing dependence on foreign investors and consulting companies.

Hanoi, 24th December 2025

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