


کد سند: RO-S-F-28-02	معاونت پژوهشی	
تاریخ صدور: ۱۳۹۹/۴/۲۲		
تاریخ ویرایش: ۱۳۹۹/۵/۱۵	فرم خلاصه انگلیسی طرح/پروژه	

Project Title: The Future of Control Systems in Wind Turbines

Department:	Power Plant Monitoring and Control Department	Employer:	Research Affairs Office
Project/Program Manager:	Ali Poureh	Executor:	HamidReza Khalesi
Project Financial Code:	916000	Project Quality Code:	PECPN16
Type of Project/Program:	Futures Studies	Assistant:	Research

Project Staff: Majid Firouzbahrami, Mohammad Doremami, Mohammad Rasouli

Keywords: Wind Turbine, Control System, Futures Studies, Dynamical Control, Advanced Control, Trend Analysis, Patent Analysis, Environmental Scanning

Project Necessity:

Several motives have helped the wind energy market to grow and stay competitive in recent years. Apart from the renowned renewable energy targets such as reducing CO₂ emissions, continual falls in the costs of wind energy production have been the chief drive for further investments and installations. As an economical approach for adding new power generation capacities, the wind energy sector has become more competitive in recent years, resulting in a challenging situation for wind turbine manufacturers.

This imperative indicates that wind turbine technology development is a high-priority issue for the developers. Undoubtedly, part of this necessity is shouldered on the control system that could substantially enhance wind turbine operation by reducing the exerted loads on various parts of the turbine and increasing the quality of produced power. Imposing new objectives on the control system, however, makes the wind turbine control design a multi-objective problem for which the classical design approaches are becoming unwieldy. Admittedly, until today the classical control system design methods have proven to be more appealing. However, they heavily rely on the expertise of the control system designer; Thus, they are highly likely to be gradually replaced by advanced design methods due to the capability of advanced techniques in handling complex problems more systematically.

Iran's wind energy sector is rapidly growing due to the supporting policies of the Ministry of Energy in recent years. R&D groups in large corporations such as the MAPNA Group are now investing in the development of large-scale wind turbines. Thus, the abovementioned trend notifies the necessity of carrying out studies aiming to unravel the underlying trends toward future wind turbine control systems. The output of such studies could be used to update the supporting policies to guide such R&D groups toward directions with higher success probability in the near future.

Project Goals:

The project is an attempt to investigate the atmosphere of control engineering applications in large-scale wind turbines to provide a clear understanding of various challenges involved in such practices. This differs from regular literature reviews carried out at the beginning of a research project. A more accurate extrapolation of current trends from different aspects requires more sophisticated tools and apparatus. Exploring wind turbine control systems from academic, innovation, and industrial points of view will provide us with a clear picture of the viability of novel ideas. Based on such inspections, we predict the main trends in academic research, commercialization, and industrial applications. Various bibliometric tools and techniques will assist us in this regard.

Abstract:

In this project, the future of control systems in wind turbines is predicted. Various methods such as science fiction, relevance trees, literature review, patent analysis, scanning, and expert panel are applied in our studies. The reason behind choosing these methods is depicted by investigating the relevance of our studies to various nodes of the Popper's diamond. With the aid of the science-fiction method, we have investigated major events and trends connected to the control system of large-scale wind turbines and have proposed viable future mainstream scenarios. Our literature review is refined and polished using different analysis tools and software pieces such as google scholar, publish or perish, and VOSviewer. The period of our investigation is limited to two recent decades, which is sufficiently long for this arising industry. Commercialization trends are discussed based on the information of significant patents available on the Internet. The results of these studies have helped create a relevance tree for our studies. Moreover, we have established an expert panel to validate the results of our studies by interviewing experts in this field. Finally, such data are utilized to prioritize future trends based on each chosen futuristic technique.

Steps and Methodologies:

1- Fundamental of futures studies in wind turbine control systems

- a. The investigation of the theoretical basis and the selection of futures studies techniques.

In this stage, the theoretical basis of futures studies is investigated. The characteristics of our studies are determined from various aspects. Then, depending on the relevance of these characteristics to each node of the Popper's diamond suitable futures studies techniques are selected.

2- Futures studies in wind turbine control systems

- a. The investigation of change trend in wind turbine control systems based on the selected techniques

In this stage, every chosen technique is implemented through extensive research. Every technique requires gathering a vast amount of data from different resources. These data are then methodically analyzed to unravel the hidden trends in the development of wind turbine control systems.

- b. Specifying the probable futures in wind turbine control systems

By prioritizing the trends obtained in the previous section and by information fusion, the probable futures given by each technique are specified in this stage.

3- Summary and Conclusion

- a. Summary and proposals for future research

In this phase, a summary of all the findings of this project is detailed concisely. Readers who want to find out about the applied methodologies and the final results may read this report instead of the lengthy reports of the previous phases.

Main Results (technical outputs, patents, papers, books, reports, etc.):

The following reports are written as the main results of this project:

- 1- Ali Pouerh, Majid Firouzbahrami, Mohammad DoreEmami, Mohammad Rasouli, Fundamentals of future studies in wind turbines, , Power Plant Monitoring and Control Department, Niroo Research Institute, PECPN16/T1, January 2019
- 2- Ali Pouerh, Majid Firouzbahrami, Mohammad DoreEmami, Mohammad Rasouli, Future studies in wind turbine control systems, , Power Plant Monitoring and Control Department, Niroo Research Institute, PECPN16/T2, September 2019
- 3- Ali Pouerh, Majid Firouzbahrami, Mohammad DoreEmami, Mohammad Rasouli, A Managerial report on future studies in wind turbine control systems, Power Plant Monitoring and Control Department, Niroo Research Institute, PECPN16/E, November 2019