# 結合GQM、FDEMATEL與ANP探討風力發電場設置評估因素之研究


## 黃鈺郎、葉子明

E-mail: 345509@mail.dyu.edu.tw



**摘 要**

近年來由於國內風機數量的快速增加，且風能發展遠比過去更加複雜的情形下，風場設置後的可能影響及民眾對於風力發電之感受和認知情形，應是能源業者於風力發電場設置前需要釐清的重要事宜。 本研究探討風力發電場設置時所應考慮的因素，同時瞭解不同屬性的產業對於設置評估因素之差異。本研究以安全與品質、經濟與效益、社會觀感、環境與生態、法規及政策之六個構面及28個評估準則來找出設置因素間彼此的影響關聯，並利用決策實驗室分析法(Decision Making Trial and Evaluation Laboratory, DEMATEL)找出各項構面之間的關聯結構，並利用分析網路程序法(Analytic Network Process, ANP)來找出準則之間的權重關係。研究結果發現安全與品質及環境與生態是兩大最主要的影響構面。而準則權重方面，業界看法對於安全設置距離是最為重視的，學界則對於環境生態的監測最為看重。 評估的結果可提昇民眾對於風力發電的了解、提供國內能源策略及有意投資風力發電之民間業者參考，以便將有限的資源做最佳的分配，達到最高的效益，有助於國內能源多元化與自主。



關鍵詞 : 風力發電、模糊決策實驗室分析法、分析網路排序法


**目錄**

**參考文獻**

一、中文文獻 1. 林致偉(2004)，以模糊的目標-問題-度量指標方法論為基礎之軟體度量系統，東海大學資訊工程與科學研究所碩士論文。 2. 邱佩冠(2005)。再生能源的發展－以美國再生能源發展為例。全國變遷通訊雜誌，44，28-32。 3. 張魁?(2009)。Super Decisions操作軟體手冊:以ANP突破AHP的研究限制。台北:鼎茂。 4. 曹正雄(2010)。層級分析法AHP與BOCR應用於再生能源-風力發電場選擇之研究。國立勤益科技大學工業工程與管理研究所碩士論文。 5. 黃世禎(2006)，國內組織CMMI流程改善量化績效指標制訂，經濟部工業局95年度提昇資訊軟體計畫，1-213。 6. 經濟部產業技術白皮書(2010)，經濟部能源局網站。 7. 簡明春(2006)，電機機械雜誌，116，55-57。 8. 陳正和(2006)。風力發電之應用和效益，電力專欄，527，30-33。 9. 顏嘉良(2008)，台灣風力發電推廣廣策略及效益評估之研究，國立彰化師範大學電機工程研究所碩士論文。 10. 鄭孟寧(2009)。邁向永續能源之路—借鏡丹麥，能源報導，4，11-14。 二、英文文獻 1. Arnett, E.B., Brown, W.K., Erickson, W.P., Fiedler, J.K., Hamilton, B.L., Henry, T.H., Jain, A., Johnson, G.D., Kerns, J., Koford, R.R., Nicholson, C.P., O ’ Connell, T.J., Piorkowski, M.D. and Tankersley, R.D., (2008), Patterns of bat fatalities at wind energy facilities in North America. Journal of Wildlife Management, 72(1), 61 – 78. 2. Aras, H., Erdogmus, S. and Koc, E., (2004), Multi-criteria selection a win observation station location using analytic hierarchy process. Renewable Energy, 29(8), 1383-1392. 3. Braunholtz, S., (2003), Public Attitudes to Windfarms: A Survey of Local Residents in Scotland. Scottish Executive, Social Research. 4. Bell, D., Gray, T. and Haggett, C., (2005), The ‘ social gap ’ in wind farm siting decisions: explanations and policy responses. Environmental Politics, 14(4), 460 – 477. 5. Bolinger, M. and Wiser, R., (2009), Wind power price trends in the United States: struggling to remain competitive in the face of strong growth. Energy Policy, 37(3), 1061 – 1071. 6. Chen, H.H., Kang, H.Y. and Lee, H.I., (2010), Strategic selection of suitable project for hybrid solar-wind power generation systems. Renwable and Sustainable Energy Review, 14(1), 413-421. 7. Carrete, M., Sanchez, J.A. and Benitez, J.R., (2011), Large scale risk-assessment of wind-farms on population viability of a globally endangered long-lived raptor. Biological Conservation, 142(12), 2954-2961. 8. Chen, C.H. and Tzeng, G.H., (2011), Creating the aspired intelligent assessment systems for teaching materials. Expert Systems with Applications, 38(10), 12168-12179. 9. Chen, F.H. and Hsu, T.S., (2011), A balanced scorecard approach to establish a performance evaluation and relationship model for hot spring hotels based on a hybrid MCDM model combining DEMATEL and ANP. International Journal of Hospitality Management, 30, 908-932. 10. Doukas, H., Patlitzianas, K.D. and Parras, J., (2006), Supporting sustainable electricity technologies in Greece using MCDM. Science Direct, 31, 129-136. 11. Berry, D., (2009), Innovation and the price of wind energy in the US. Energy Policy, 37(11), 4493-4499. 12. Desholm, M., (2009), Avian sensitivity to mortality: Prioritising migratory birds pecies for assessment at proposed wind farms. Journal of Environmental Management, 90(8), 2672-2679. 13. Devries, J.M., Vuuren, D.P. and Hoogwijk, M.M., (2007), Renewable energy sources: their global potential for the first-half of the 21st century at a global level: an integrated approach. Energy Policy, 35, 2590 – 2610. 14. Dimitropoulos, A. and Kontoleon, A., (2009), Assessing the determinants of local acceptability of wind-farm investment: a choice experiment in the Greek Aegean Islands. Energy Policy, 37(5), 1842 – 1854. 15. Eltham, D., Harrison, G. and Allen, S., (2008), Change in public attitudes towards a Cornish wind farm: implications for planning. Energy Policy, 36(1), 23 – 33. 16. EWEA (2010), Powering the energy debate . European Win Energy Association, 1 – 54. 17. Groothuis, P.A., Groothuis, J.D., Whitehead, J.C., (2008), Green vs. green: measuring the compensation required to site electrical generation windmills in a viewshed. Energy Policy, 36, 1545 – 1550. 18. Gross, C., (2007), Community perspectives of wind energy in Australia: the application of a justice and community fairness framework to increase social acceptance. Energy Policy, 35, 2727 – 2736. 19. GWEC (2010), Gobal wind Report 2010. Annual market update, 2010, 1-60. 20. GWEC (2009), Gobal wind 2009 Report. Global Wind Energy Council, 1-63. 21. Gray, A. and MacDonell, S.G., (1997), GQM++ A Full Life Cycle Framework for the Development and Implementation of Software Metric Programs. Proceedings of ACOSM ’ 97 Fourth Australian Conference on Software Metrics, 22-35. 22. Horst, D.V. and Toke, D., (2010), Exploring the landscape of wind farm developments; local area characteristics and planning process outcomes in rural England. Land Use Policy, 27(2), 214-221. 23. Horst, D.V., (2007), NIMBY or not? Exploring the relevance of location and the politics of voiced opinions in renewable energy siting controversies. Energy policyy, 35(5), 2705-2714. 24. Hsu, C.Y., Chen, K.T. and Tzeng, G.H., (2007), FMCDM with Fuzzy DEMATEL Approach for Customers ’ Choice Behavior Model. International Journal of Fuzzy Systems, 9(4), 236-246. 25. Hazard, R. and Recoiery, T., (2008), Siting potentially hazardous facilities: what factors impact perceived and acceptable risk?. Renewable Energy, 39(4), 265-281. 26. Hung, S.J., (2011), Activity-based divergent supply chain planning for competitive advantage in the risky global environment: A DEMATEL-ANP fuzzy goal programming approach. Expert Systems with Applications, 38(8), 9053-9062. 27. Johansson, M. and Laike, T., (2007), Intention to respond to local wind turbines: the role of attitudes and visual perception. Wind Energy, 10, 435 – 457. 28. Jones, C.R. and Eiser J.R., (2010), Understanding ‘ local ’ opposition to wind development in the UK: How big is a backyard?. Energy Policy, 38, 3106-3117. 29. Hurtado, J.P., Fernandez, J., and Parrondo, J.L., (2004), Spanish method of visual impact evaluation in wind farms. Science Direct, 8, 483-391. 30. Liou, J.H., Wang, H.S. and Hsu, C.C., (2011), A hybrid model for selection of an outsourcing provider. Applied Mathematical Modelling, 35(10), 5121-5133. 31. Lee, H.I. and Chen, H.H., (2009), Multy-criteria decision making on strategic of win farms. Renewable Energy, 34, 120-126. 32. Klick, H. and Smith R.A., (2010), Public understanding of and support for wind power in the United States. Renewable Energy, 35, 1585-1591. 33. Khomh, F., Vaucher, S.P. and

Gueheneuc, Y.G., (2010), BDTEX: A GQM-based Bayesian approach for the detection of antipatterns. The Journal of Systems and Software, 84, 559 – 572. 34. Kunz, T.H., Arnett, E.B., Erickson, W.P., Hoar, A.R., Johnson, G.D., Larkin, R.P., Strickland, M.D., Thresher, R.W., Tuttle, M.D., (2007), Ecological impacts of wind energy development on bats: questions, research needs, and hypotheses. Frontiers in Ecology and the Environment, 5, 315 – 324. 35. Li, R.J., (1999), Fuzzy method in group decision making. Computers and Mathematics with Applications, 38(1), 91-101. 36. Lee, W.B., Lau, H., Liu, Z.Z and Tam, S., (2001), " A fuzzy analytic hierarchy process approach in modular product design ". Expert System, 18(1), 32-41. 37. Lin, C.J. and Wu, W.W., (2008), A causal analytical method for group decision- making under fuzzy environment. Expert Systems with Applications, 34(1), 205-213. 38. Lin, C.L. and Tzeng, G.H., (2009), A value-created system of science ( technology ) park by using DEMATEL. Expert Systems with Applications, 36, 9683-9697. 39. Liou, J.H., Yen, L. and Tzeng, G.H., (2008), Building an effective safety management system for airlines. Journal of Air Transport Management, 14, 20-26. 40. Mona, A. and Daniel, N., (2011), Assessing information quality of e-learning systems :a web mining approach. Computers in Human Behavior, 27(2), 862-873. 41. Macdonell, S.G., (1997), Deriving Relevant Functional Measures for Automated Development Project. Information and software Technology, 35(9), 499-512. 42. Nadai, A., (2007), ' ' Planning ' ', ' ' siting ' ' and the local acceptance of wind power:Some lessons from the French case. Energy Policy, 35(5), 2715-2726. 43. Olsson, T.P., (2001), V-GQM: A Feed-Back Approach to Validation of a GQM Study. Software Metrics Symposium, Proceedings Seventh International, 4-6. 44. Pedersen E., Berf, F.V., (2010), Can road traffic mask sound from wind turbines ? Response to wind turbine sound at different levels of road traffic sound. Energy Policy, 38, 2520-2527. 45. Pierpont, M.D., (2010), Wind Turbine syndrome. A report on natural Experiment, Pierpont Publication. 46. Ryunosuke, K., (2008), Adverse impacts of wind power generation on collision behaviour of birds and anti-predator behaviour of squirrels. Science Direct, 16(1), 44-55. 47. Rodrigues, R.B., Mendes, V.M., (2011), Protection of wind energy systems against the indirect effects of lightning. Renewable Energy, 36, 2888-2896. 48. Saaty, T. L. and Takizawa, M., (1986), " Dependence andindependence: From linear hierarchies to nonlinear networks ". Eurpean Journal of Operational Research, 26, 229-237. 49. Saaty, T.L., (1996), " Decision making with dependence and feedback: The analytic network process ". Pittsburgh, PA: RWS Publication. 50. Saaty, T.L., (2001), " The analytic network process ". Pittsburgh, PA: RWS Publication. 51. Saaty, T.L., (2006), " Rank from comparisons and from ratings in the analytic hierarchy/network processes ". European Journal of Operational Research, 168(2), 557-570. 52. Schiermeier, Q., Tollefson, J., Scully, T., Witze, A. and Morton, O., (2008), Electricity without carbon. Nature, 454, 816 – 823. 53. Simone, K. and Frohlingsdorf, M., (2007), The Dangers of Wind Power. Der Spiegel, 34. 54. Swofford, J. and Slattery, M., (2010), Public attitudes of wind energy in Texas: Local communities in close proximity to wind farms and their effect on decision-making. Energy Policy, 38(5), 2508-2519. 55. Seo, D., Ranganathan, C. and Babad, Y., (2008), " Two-level model of customer retention in the US mobile telecommunications service market ". Telecommunication Policy, 32(3), 182-196. 56. Sibille, T., Cloquell, V.C. and Darton, R., (2009), Development and validation of a multicriteria indicator for the assessment of objective aesthetic impact of wind farms. Science Direct, 13, 40-66. 57. Tegou, L.I., Polatidis, H. and Haralambopoulos, D.A., (2010), Environmental management framework for wind farm siting: Methodology and case study. Journal of Environmental Management, 91(11), 2134-2147. 58. Tseng, M.L. (2009), Using the extension of DEMATEL to integrate hotel service quality perceptions into a cause – effect model in uncertainty. Expert systems with Applications, 36(5), 9015-9023. 59. Tsai, W.H. and Chou, W.C., (2009), Selecting management systems for sustainable development in SMEs: A novel hybrid model based on DEMATEL, ANP, and ZOGP. Expert Systems with Applications, 36(2), 1444-1458. 60. Tseng, M.L., (2009), A causal and effect decision making model of service quality expectation using grey-fuzzy DEMATEL approach. Expert Systems with Applications, 36(4), 7738-7748. 61. Tseng, M.L., (2009), Using the extension of DEMATEL to integrate hotel service quality perceptions into a cause-effect model in uncertainty. Expert Systems with Applications, 36(5), 9015-9023. 62. Tzeng, G.H., Chiang, C.H. and Lin C.W., (2007), Evaluating intertwined effects in e-learning programs: A novel hybrid MCDM model based on factor analysis and DEMATEL. Expert Systems with Applications, 32(4), 1028-1044. 63. Tsai, W.H., Chou, W.C. and Lai, C.W., (2010), An effective evaluation model and improvement analysis for national park websites: A case study of Taiwan. Tourism Management, 31(6), 936-952. 64. Tsai, W.H. and Kuo, H.C., (2011), Entrepreneurship policy evaluation and decision analysis for SMEs. Expert Systems with Applications, 38(7), 8343-8351. 65. Tsai, W.H. and Leu, J.D., (2011), A MCDM approach for sourcing strategy mix decision in IT projects. Expert Systems with Applications, 37(5), 3870-3886. 66. Tsai, W.H. and Chou, W.C., (2011), An effectiveness evaluation model for the web-based marketing of the airline industry. Expert Systems with Applications, 10, 1016-1024. 67. Wu, W.W., (2008), Choosing knowledge management strategies by using a combined ANP and DEMATEL approach. Expert Systems with Applications, 35, 828-835. 68. Warren, C.R., Lumsden, C., O ' Down, S. and Birnie, R.V., (2005), ' Green On Green ' : public perceptions of wind power in Scotland and Ireland. Journal of Environmental Planning and Management, 48(6), 853 – 875. 69. Warren, C.R., Mcfadyen, M., (2010), Does community ownership affect public attitudes to wind energy?A case study from south-west Scotland. Land Use Policy, 27(2), 204 – 213. 70. Wallace, J.R. and Dawson, M., (2009), O&M safety at the wind farm. renewable energy focus, 10(5), 28-30. 71. Wolsink, M., (1994), EntanglementofInterestsandmotives—assumptions behind the NIMBY-theoryonfacilitysiting. Urban Studies, 31(6), 851 – 866. 72. Wu, W.W. and Lee, Y.T., (2007), Developing global manager ' s competencies using fuzzy DEMATEL method. Expert Systems with Applications, 32, 499-507. 73. Wu, W.W., (2008), Choosing knowledge management strategies by using a combined ANP and DEMATDL approach. Expert Systems with Applications, 35, 828-835. 74. Wolsink, M., (2010), Near-shore wind power—Protected seascapes, environmentalists ' attitudes, and the technocratic planning perspective. Land Use Policy, 27(2), 195-203. 75. Wolsink, M., (2007), Wind power implementation: The nature of public attitudes: Equity and fairness instead of ' backyard motives ' . Science Direct, 11(6), 1188-1207.