id	session code	title	Presenter name	Affiliation
53	C-2-1	A verification of the FRT (Fault Ride Through) capability for 5MW wind turbine system	Mr. Yuta Ito	Hitachi, Ltd.
161	C-2-2	Study the effect of the grid and the connected distribution generators on IEC 61400-21 power quality assessment of the wind turbine under study	Mr. Ali Mahmoud Khazma	Department of Electrical Power and Machines, Cairo University, Giza, Cairo, Egypt
189	C-2-3	A Novel Optimization Method for Wind Power Integration in a Hybrid Renewable Energy System	Mr. Ulas Baran Baloglu	Tunceli University
137	C-2-4	Techno-economic Evaluation and Electricity Tariff Sensitivity Analysis of Wind Energy Based Industrial Microgrid with Third-Party Ownership and Power Purchase Agreement Business Model	Mr. Solomon Netsanet Alemu	North China Electric Power University (PhD student) and Goldwind Science & Tech Co. Ltd (Intern)
5	C-2-5	Over ten years of offshore wind project finance: Lessons learnt and their applicability to Japan	Mr. Caedmon Shayer	Mott MacDonald

A verification of the FRT (Fault Ride Through) capability for 5MW wind turbine system

Yuta Ito, Kiyoshi Sakamoto, Hikaru Meguro and Mitsuru Saeki

Hitachi, Ltd.

Abstract:

With expansion of the renewable energy, the fault ride through (FRT) capability is required for renewable energy sources, such as wind turbine generators, photovoltaic power generation system, etc., by grid code of each country. Wind turbine should continue generation driving during voltage dip if the dip level and duration is lower / shorter than the curve defined by grid code.

To verify FRT capability of Hitachi's newly developed wind turbine system, HTW5.0-126, the factory bench test and prototype test were carried out. By these test, control logic and parameters of wind turbine controller and power conditioning system (PCS) are adjusted.

Additional equipment was installed in the medium voltage line between wind turbine generator and substation for performing FRT test at the prototype turbine. The equipment is designed to make four voltage dip levels, 84%, 49%, 22% and 0%, by changing combination of the reactor coil.

In case of the wind turbine operating between 10% and 30% and above 90%, voltage dip test were carried out. As a result, the wind turbine continued generation driving during voltage dip in all condition. In addition, the output power of the wind turbine returned to more than 80% of the output power before voltage dip within 1s and it became the normal operating conditions. Also, the change of the output power of wind turbine and rotational speed of the generator converged immediately at the time of the voltage dip and return. Therefore, it is confirmed the validity of the control design to minimize axis torsion vibration.

It is confirmed that HTW5.0-126 satisfied the FRT demand specifications at a temporary voltage dip based on the above mentioned verification.

Study the effect of the grid and the connected distribution generators on IEC 61400-21 power quality assessment of the wind turbine under study

Ali Mahmoud Khazma[1], Hosam Kamal Youssef[1], Abou Baker Abdel-Hameed Slim[2] and Aubai kinana Al-khatib[4]

[1]Department of Electrical Power and Machines, Cairo University, Giza, Cairo, Egypt,

[2]Department of Electrical Power and Machines, Cairo University, Giza, Cairo, Egypt,

[3]New and Renewable Energy Authority, Ministry of Electricity & Energy, Cairo, Egypt,

[4]Renewable Energy and Energy Efficiency, Kassel University, Kassel, Germany

Abstract:

The increasing integration of wind power into existing power system provides technical challenges with problems in power quality and grid stability. IEC 61400-21 describes procedures for determining the power quality characteristics of wind turbines. This paper shows measurements by using matlab/simulink that include calculating the flicker values like flicker coefficient & flicker step factor with different grid phase angle settings according to IEC 61400-21 and the positive sequence values of an electrical system (from its voltage and current measurements) like the active and reactive power and the three phase root-mean-square values of the measured voltages and currents. As a result of this study, the effects of the other wind turbines, connected to the same point of common coupling of the tested wind turbine, with different power generation levels are shown. The short circuit ratio is taking as main criteria for identifying the strengths of the grid. Depending on the generation levels of the connected wind farms the changes in the short circuit ratio were calculated and resulted in considering the grid as a weak grid (Short Circuit Ratio < 4). By limiting the maximum allowed generation levels of the other wind farms (the Limitation Ratio = $(S_{WF1} + S_{WF2\_max})/(S_{WF1\_max} + S_{WF2\_max}) = 0.5$) and studying the flicker levels at the wind turbine of interest for a specific generation level ($P/P_n = 30\%$), a reduction in the flicker level was noticed (about $C(\psi_{avg\_GridTopolgy3})/C(\psi_{avg\_GridTopolgy2}) = 85.47\%$).

A Novel Optimization Method for Wind Power Integration in a Hybrid Renewable Energy System

Ulas Baran Baloglu[1] and Yakup Demir[2]

[1]Tunceli University, [2]Firat University

Abstract:

Smart grids differ from the traditional grids by using advanced sensors, smart metering devices and novel information and control technologies. Advances in smart grid open new dimensions for renewable integration. Previously, there are three major approaches for wind integration to the grid. Those approaches are expert systems, heuristics, and mathematical techniques. The primary challenge is the reliability of this integration due to seasonal data and forecast errors. As the wind is fluctuating, power variations may exist in the grid, and computational solutions don't produce a solution to the generation of these variations. Wind energy could be scheduled to the late evening hours. Otherwise, it will become surplus.

Hybrid renewable energy system applications are among popular environmental friendly solutions. Vehicle to grid (V2G) is the concept of using Electric Vehicle (EV) batteries as an energy storage and to create a distributed energy resource (DER). The integration of V2G with wind generation has a significant impact on the efficient operation of a hybrid renewal system.

The proposed optimization method schedule connections of electric vehicles (EVs) and efficiently optimize the construction of a distributed energy resource (DER) that optimizes integration of renewables. A novel optimization method based on lottery-based scheduling is used, and it is compared to other optimization alternatives. Results show the effectiveness of the proposed method and its potential for creating a robust hybrid renewable system.

Techno-economic Evaluation and Electricity Tariff Sensitivity Analysis of Wind Energy Based Industrial Microgrid with Third-Party Ownership and Power Purchase Agreement Business Model

Solomon Netsanet Alemu[1], Dehua Zheng[2], Jianhua Zhang[3], Dan Wei[2] and Xinhua Wan[2]

[1]North China Electric Power University (PhD student) and Goldwind Science & Tech Co. Ltd (Intern),

[2]Goldwind Science and Technology Co. Ltd., [3]North China Electric Power University

Abstract:

Fueled by the rapid growth and financial competitiveness of renewable energy and smart grid technologies, industrial microgrid with varying types of ownership and financing options has become a viable solution to supply energy to industrial complexes. The focus of this study is the specific model by which an industrial microgrid is built and administered by a third party while the generated power is sold to an industry based on Power Purchase Agreement (PPA). The rate of PPA is made to rest between the utility selling and buying tariffs which makes it a win-win scenario for both sides. The comparative advantages of this business model are discussed based on observed practices.

The economics, operational performance and environmental emissions are evaluated for an industrial microgrid (inspired by and evolved from an operational microgrid) dominated by a wind turbine while containing a set of PV panels and energy storage as well. The modeling and optimizing software for hybrid renewable energy systems, HOMER, is used. The results of the study showed that an optimally operated microgrid consisting of 2MW wind turbine, 100kW PV and 576 kWh energy storage system can bring about a 4% reduction in the energy bill by the industry with a peak load of 3.727MW while the risk for power interruption can be curtailed considerably as well. The renewable fraction is around 0.25. The system has also exhibited environment friendliness as expressed by the reduction in annual CO2 emission by more than 4.4 million kg relative to being supplied by the grid all the time.

As the utility legislations, most commonly utility rate, are very significant in affecting the economics of a microgrid, the study is extended to sensitivity analysis of the microgrid as a result of variations in the utility rate. The different electricity pricing types (constant rate, scheduled rate and real time/market based rate) are compared. The changes in COE Solomon Netsanet, D.H. Zheng, Senior Member, IEEE and J.H. Zhang, Member, IEEE , Dan Wei, Wanxinhua as a result of variation in the utility rate were computed and compared as well. The real time market based rate was seen to be the most favorable for the microgrid. Thus, it is recommended for better deployment of renewable energy technologies. The change in average power price is seen to affect the relative share of capital cost for system components in the total NPC by a 2:0.54 ratio, thus, raising the rate will have a significant encouraging impact to development of renewable based microgrids.

OVER TEN YEARS OF OFFSHORE WIND PROJECT FINANCE: LESSONS LEARNT AND THEIR APPLICABILITY TO JAPAN

Caedmon Shayer and David Mudie

Mott MacDonald

Abstract:

How do we make sure that lessons learnt from more than ten years of non-recourse project finance experience are captured for future projects? How can these lessons be applied to the Japanese environment and how do we make sure that problems of the past will not be repeated? Approaches towards risk management may be similar for different offshore wind developers but effectiveness of mitigation measures may differ significantly, especially during project construction. Experience and track record is always the key but how does it fit in the overall picture to deliver a successful project within time and budget? This presentation is based on work carried out by Mott MacDonald in its role as lenders' technical advisor to lenders. Work has covered more than 20 projects, of which 13 have reached financial close, seven are in operation and the remainder are in construction. The key aspects of the technical due diligence process followed remain the same however each project is unique and as the industry evolves different aspects are given different attention. Lessons learnt include the following aspects of the project:

· Project participants; · Design and certification; · Contract Structure; · Installation; · Schedule; · O&M strategy;

· Permits; and · Contracts.

These lessons are based on the construction and operation experience gained from seven debt financed offshore wind farms in Europe under operation which have been taken into consideration during our due diligence work that led to a number of industry milestones including attracting and securing the largest non-recourse financing in renewables history, the EUR 2.1 billion Gemini offshore wind farm. Conclusion With appetite in offshore wind finance growing, what are the lessons learnt from more than ten years of non-recourse project finance experience? How can these lessons be applied to the Japanese environment and how do we make sure that problems of the past will not be repeated? This presentation is based on work carried out by Mott MacDonald in its role as lenders' technical advisor. Work has covered more than 20 projects, of which 13 have reached financial close, seven are in operation and the remainder are in construction. The presentation will close with some interesting facts in technology trends (turbines, foundations and cables), risk allocation and offshore wind cost reduction trends. Learning objectives How do we make sure that lessons learnt from more than ten years of non-recourse project finance experience are captured for future projects? How can these lessons be applied to the Japanese environment and how do we make sure that problems of the past will not be repeated? This presentation is based on work carried out by Mott MacDonald in its role as lenders' technical advisor. Work has covered more than 20 projects, of which 13 have reached financial close, seven are in operation and the remainder are in construction.