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Improved System Operations with High Penetration of Wind Power: A Dialog between Academia and Industry - Ireland

Michael Power, *Senior Member, IEEE*, and Mark O'Malley, *Fellow, IEEE*

Abstract — This is a submission to a panel session at the 2010 IEEE PES General Meeting. It discusses effective collaboration between academia and industry.

Index Terms—Wind Power Generation, Power System Control, Power System Modeling.

I. INTRODUCTION

THIS document discusses one example of effective collaboration between academia and industry. The collaboration relates to the power system in Ireland which has seen wind penetration reach 45% on occasions. The collaboration occurs between the Electricity Research Centre (ERC - www.ucd.ie/erc) in University College Dublin (UCD) and the industry in Ireland which includes the TSO, DSO, generators, manufacturers and others. The ERC is an industry-university research collaboration with research driven by the energy industry worldwide with a particular emphasis on the Irish electricity sector. The ERC although based in UCD has another branch in Trinity College Dublin (TCD) and works with other Irish universities and collaborates with institutes in Denmark, Britain and the U.S. The ERC is governed by a board which is made up of industry members and representatives from the energy regulator, government departments and other related government sponsored bodies.

II. EXAMPLE

The headings under which this example of collaboration will be discussed are the following:

- Financial support
- Staff
- Power system operation issues and data
- Research
- Future challenges
- Application of ERC research
- Panel session overview

A. Financial support

Financial support for the research undertaken by the ERC is obviously critical to its success. All industry members of the ERC provide annual financial support which is used to carry out relevant research and support post graduate students. As well as supporting the ERC directly, the ERC and industry have jointly applied for research grants. This is an approach which is encouraged by government as it is seen as a method of stimulating national economic growth.

B. Staff

There is a high level of interaction between the ERC and its industry members. This includes:

- Students graduating from the ERC taking up industry positions
- Academic staff and students working in industry for agreed durations as part of their research or studies
- Industry staff undertaking research in the ERC
- Retiring industry staff undertaking roles in the ERC

C. Power system operation issues and data

Due to its close links with industry the TSO and DSO regularly update ERC on key power system issues. This is particularly useful given the rapid growth of renewables, at both the transmission and distribution levels, on the Irish power system. The current split of renewable generation between the two network levels is 60% on the distribution network and 40% on the transmission network.

Industry participants also provide the ERC with data which is critical for the researchers. For example, the ERC now has the last 10 years on wind data for the entire island which it can use for analysis. The TSO also provides ERC with extensive post fault data which allows the ERC to verify and correct their power system models.

D. Research

As outlined in the introduction, the ERC's research agenda is mandated by the industry and its requirements. The results of the research carried out by the ERC are freely available to the ERC's industrial participants. In order to broaden the industry's appreciation of the research, which may be undertaken at an analytical level not normally encountered in

M. Power and M. O'Malley are with the School of Electrical, Electronic, and Mechanical Engineering, University College Dublin, Dublin 4, Ireland (e-mail: michael.power@ucd.ie; mark.omalley@ucd.ie).

the industry work place, industry staff work in the ERC on appropriate research topics.

The industry and ERC work together to produce joint papers so that they both, include the outcome of current research, and address industry needs [1, 2].

E. Future challenges

The ERC is undertaking research in the following areas, with a view to producing realizable solutions which will be required for 2020 when the annual energy produced from renewables in Ireland is scheduled to reach 40% [3].

- Active distribution networks
- Stochastic unit commitment
- Security constrained transmission operations

It is envisaged that the industry will provide test beds for some or all of the proposed solutions.

F. Application of ERC Research

Three applications of ERC research are discussed in this section.

Use of power system model in analysis of system for 2020

In 1999 a Matlab model [4] was developed in the ERC to study reserve requirements for the Irish system, which is an isolated island system. This model has since been enhanced by the inclusion of models for generators such as combined cycle gas turbines (CCGTs) and different types of wind generators. This model is now being used to study the future effects of high levels of wind penetration on frequency control and regulation.

High level study of suitable generation portfolios for the All-Island system in 2020.

To achieve the objective of examining a range of portfolios for the All-Island Grid Study, the study utilized a least-cost generation portfolio optimization algorithm developed by the ERC [5, 6]. Details of this study have been published in several places [7]. The methodology assesses the key high level factors which affect the cost of electricity using a linear programming algorithm. The algorithm optimizes the least-cost generation portfolio for the given conditions for a single year, which in this case is 2020. The least-cost algorithm used here has been specifically developed to handle the unique features of wind generation which is likely to be a significant contributor to the All-Island generation mix by 2020. Established generation packages which have been developed around traditional thermal, hydro and nuclear generation options did not at the time of the study account for the features of wind generation.

Enhanced Utilisation of Voltage Control Resources With Distributed Generation.

Distributed Generation (DG) is increasing in penetration on power systems across the world. In rural areas, voltage rise limits the permissible penetration levels of DG. Another increasingly important issue is the impact on transmission system voltages of DG reactive power demand. ERC proposed a passive solution to reduce the impact on the transmission system voltages and overcome the distribution voltage rise barrier such that more DG can connect [8, 9]. The fixed power factors of the generators and the tap setting of the transmission transformer are determined by a linear programming formulation. The method is tested on a sample section of radial distribution network and on a model of the all island Irish transmission system illustrating that enhanced passive utilisation of voltage control resources can deliver many of the benefits of active management without any of the expense or perceived risk, while also satisfying the conflicting objectives of the transmission system operator.

This method utilises the reactive support resources for the benefit of the distribution system and transmission system. The method has been well received by EirGrid the Irish TSO and ESB Networks, the Irish DSO.

ESB Networks see potential benefits in it and have adopted it as part of their smart networks plan. It is planned to run a trial of the method on a section of the Irish distribution network where there is a cluster of DG units, thus providing a good test of the method's robustness.

G. Panel session overview

The presentation at the session will address each of the sections outlined in this paper. At least one slide will be used to discuss each of the sections II A to II F. I will also provide an introduction to the Irish power system and the ERC in order to set the context for the discussions.

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