Title: **Wind power integration into the Chilean Northern Interconnected Power System (SING)**

Authors: Darío Lafferte, M.Sc. [1](*) and Prof. Dr.-Ing. Peter Zacharias[2]

Affiliations: [1,2] Department of Electrical Power Supply Systems, University of Kassel, Germany

Abstract:

Wind power becomes important into the Chilean electricity market with an increasing number of projects [1], as a reaction to the legal reforms to promote the renewable energies for power generation and the energy crises of the last decade. Chile has a significant lack of own fossil resources and is highly dependent on imported energy sources, situation which has led to regular power shortages. The challenge for Chile is to achieve an important energy security and the diversification of the energy matrix through the procurement of own renewable energy resources. The entire Chilean power system is divided in two big interconnected power systems and two small grids because of the country's geography and the huge distances causing different challenges for the grid voltage stability. The present work focuses on voltage stability impact of large wind power integration into the Northern Interconnected Power System (SING). The SING is a strong predominant thermoelectric system (99.8% [2]), which corresponds to about 25% of the entire installed capacity of Chile and powers the cooper mining industry, which is fundamental for the Chilean economy. By the end of 2013, there was no wind power feeding into the SING [2]. Furthermore, the SING has a longitudinal structure with a negative impact on the grid voltage stability. Nevertheless, most stability studies are focused in mesh networks and their results are not directly transferable to longitudinal systems [3].

This work considers the best wind locations for power generation [4], which are situated on considerable heights; and consequently the failure risk of the power electronic increases due to the cosmic rays influence. In addition, a deregulated generation market, the new grid code [5] and the renewable energies legal framework require cost-efficient alternatives and wind energy converters (WEC), which are capable to support the grid voltage at the connection point. Doubly fed induction generators (DFIG) fulfil Chilean fault ride through requirements, dispose of a limited semiconductors surface (minimizing the negative impact of the cosmic rays on the electronic devices) with low investment costs in comparison with other alternatives. A power system integration of DFIG-based WEC adds further difficulties to the grid keeping line voltage within tolerances. A large wind power integration can lead to problems on voltage stability, due to the dynamically wind turbines operation. The wind power integration was simulated with a 120MW wind park during faults and at quick changes of loads and power generation, considering the new grid code requirements. Moreover, the application of the crowbar protection against grid disturbances has been optimised. The maximal feasible wind power feeding into the SING was also evaluated.

References:

[1] Centro de Energías Renovables (CER), CORFO, CDEC-SING, CDEC-SIC, Estatus ERNC – Operación, report of the Centre for Renewable Energies of Chile, Santiago de Chile, 13/12/2013. http://cer.gob.cl/wp-content/uploads/downloads/2013/12/Estatus-General-Nov-_-Operacion.pdf

[2] Centro de Despacho Económico de Carga CDEC-SING, Detalle anual de capacidad instalada por empresa - capacidad instalada por coordinado periodo 2004 – 2013, November 2013. http://cdec2.cdec-sing.cl/pls/portal/CDEC.MENU_INSTAL_GENE.show

[3] C. Rahman, Auswirkungen von WEA-Einspeisung auf die Spannungsstabilität im chilenischen Übertragungsnetz, PhD thesis, Faculty of Electrical Engineering and Information Technology, RWTH Aachen University, Klinkenberg Publisher, 2010.

[4] Ministerio de Energía de Chile, Departamento de Geografía de la Universidad de Chile, Explorador de Energía Eólica – Información detallada sobre el recurso eólico disponible en Chile, research project of the Chilean Ministry of Energy, the German Society of International Cooperation (GIZ) and the Department of Geography of the Universidad de Chile, Santiago de Chile, 2012. http://ernc.dgf.uchile.cl/Explorador/Eolico2/

[5] Comisión Nacional de Energía de Chile (CNE), Norma técnica de seguridad y calidad de servicio (Chilean grid code), Santiago de Chile, August 2013.