Seminari del Departament d'Estadística i Investigació Operativa

Universitat Politècnica de Catalunya

15 de diciembre de 2025

Título: Coordinating Distributed Energy Resources under Uncertainty in Multi-Level and Flexible Energy Systems

Autor: Fernando Garcia (Universidad de Santiago de Chile)

Web: https://mcii.usach.cl/es/fernando-garc%C3%ADa

Abstract: As power systems move toward economic decarbonization and increasing decentralization, new coordination mechanisms are required to efficiently plan and operate the integration of distributed energy resources (DERs) and flexibility services. This talk presents an overview of research topics focused on optimization frameworks for the coordinated integration of DERs and uncertainty-aware decision models that support the transition toward distributed, flexible, and user-centric energy systems. Within this context, we explore hierarchical coordination models between Transmission System Operators and Distribution System Operators, and their extension to multi-voltage (MV–LV) schemes. These formulations are cast as bilevel optimization problems in which DSOs act as leaders and the TSO responds as a follower, enabling a more efficient utilization of DERs and improved congestion management across network layers. At the distribution level, optimization methods are developed for both planning and operation. For long-term planning, Hybrid Adaptive Robust-Stochastic optimization integrates stochastic and robust optimization to address uncertainty in the sizing and siting of DERs, capturing the variability of PV generation and demand growth driven by electrification while supporting efficient investment decisions. For operational management, Chance-Constrained Optimization is applied to peer-to-peer energy trading as an alternative to two-stage stochastic models, allowing communities to manage uncertainty in demand and generation without committing their full flexibility in the day-ahead market. The talk also addresses the modeling of the Chilean transmission network to assess the impact of utility-scale battery energy storage systems on curtailment reduction and to explore the design of prospective flexibility markets. Finally, ongoing work examines the role of electric-vehicle parking aggregators (V2G) in providing ancillary services and enabling the efficient integration of these emerging technologies within distribution networks.

Sobre el Autor: Fernando García-Muñoz is an Assistant Professor at the University of Santiago of Chile (USACH). His work focuses on optimization models for the planning and operation of distribution networks with high penetration of distributed energy resources. He holds a Ph.D. in Electrical Engineering and an M.Sc. in Statistics and Operations Research from the Universitat Politècnica de Catalunya. His research combines stochastic and robust optimization, decomposition algorithms, and applied modeling to design scalable and efficient solutions for modern power systems.