



**TITLE AND ABSTRACT OF THE RESEARCH TOPIC OF PHD STUDENTS IN THE PHD
PROGRAM INDUSTRIAL ENGINEERING**

XL CYCLE

Adriano Casu

Tema di Ricerca:

Development of the Electrical Distribution System for Enhanced Resilience

Abstract:

Climate Change, as a consequence of anthropogenic actions in recent decades, inevitably leads to a need for adaptation in human societies. This need arises from both measurable changes in environmental conditions (such as the increase in global average temperature) and alterations in the occurrence of extreme climatic events (heatwaves, wind storms, snowstorms, floods, wildfires, and earthquakes). The relevance of such adverse events is increasing in terms of both frequency and magnitude. Consequently, the risk associated with potential damage to human-made infrastructure is progressively growing. Among critical infrastructures, electrical systems are undoubtedly among the most vulnerable, and their disruptions affect all activities in contemporary society. Furthermore, the interdependence of the functioning of other networked infrastructures, such as transportation and telecommunications systems, with electrical systems complicates the assessment of specific risks. Therefore, there is a need for tools capable of evaluating in an integrated manner the exposure of critical infrastructures to extreme weather events and expected climate changes, their vulnerability, and their adaptive capacity to cope with both sudden and devastating events and slow but progressive and inevitable changes. The objective of this research project is to develop a planning tool that can assess the resilience of electrical systems in relation to the most impactful climatic events and propose appropriate solutions to improve their performance before, during, and after such events, including considering the possible





concurrent failure of other infrastructures, which may particularly affect the restoration phases. To this end, the study must include the development of climate scenarios suitable for describing the phenomena in question, with appropriate methods for measuring the impact of these events on electrical systems."

Lorenzo Milia

Tema di Ricerca:

Machine learning techniques for developing non-intrusive monitoring tools in thermonuclear fusion machines and facilities

Abstract:

The PhD project is related to the development of a Machine learning tool for estimating the impinging heat flux distribution on the tile surface of the Short Time Retractable Instrumented Kalorimeter Experiment (STRIKE), starting from the IR camera measures on the tile back side. The work is finalized to evaluate the uniformity and divergence of SPIDER in real time, the Source for Production of negative Ion of Deuterium Extracted from Radio Frequency developed for MITICA, the full prototype of the whole ITER Heating Neutral Beams. In addition, ML algorithms be exploited for developing an intermachine disruption predictor considering JET and ASDEX upgrade data. The activity is finalized to realize a tool able to extrapolate disruptive patterns from existing devices to next-generation tokamaks.

Alessandro Sechi

Tema di Ricerca:

Automation of the Transmission Network Management in the Sardinia Region through Artificial Intelligence

Abstract:

Managing energy systems while balancing the parameters of the Energy Trilemma (energy security, energy equity, and environmental sustainability) is no simple task. Efforts to





enhance one or more of these parameters often involve significant and costly structural investments, which, in certain cases, can lead to considerable, sometimes critical imbalances, as observed in recent years, when the transition to a more sustainable energy system has posed a challenging test from multiple perspectives. Consequently, any strategy that enhances the performance of an energy system through the optimization of the management of existing infrastructure, without necessarily requiring large-scale interventions or investments, is of great interest, particularly in isolated systems such as the Sardinia Region. This project fits within this context, aiming to develop an autonomous management system for the regional electricity transmission network, leveraging Artificial Intelligence algorithms. Once adequately trained with data obtained through Load Flow and Optimal Power Flow simulations, this system will enable optimal management of energy flows in the transmission network by measuring network operation parameters at various nodes. Through this system, the project aims to improve all the key parameters of the Energy Trilemma with respect to the Sardinian system, enhancing the resilience of the network, and thus its security, reducing management costs, contributing to energy equity by lowering supply costs for users, and finally, increasing environmental sustainability by optimizing energy flows.

Samuele Setzu

Tema di Ricerca:

Monitoring and Diagnosis of Complex Systems through Machine Learning Techniques

Abstract:

Machine Learning (ML) has rapidly evolved into one of the most transformative technologies of the modern era, revolutionizing fields from medicine to industry by enabling data-driven decision-making and predictive analytics at an unprecedented scale. Machine learning models are not inherently explainable, and efforts are even more requested to comprehend and retrace how the models came to results.

In this project different applications from heterogeneous research fields, when data-driven





approaches for solving complex problems are necessary, will be faced. In particular, applications from thermonuclear controlled fusion will be faced for machine monitoring and protection, e.g. for disruption prediction and overload detection. Moreover, application from power system monitoring and management and medical diagnosis will be faced. When possible, the project will also focus on the implementation of models that can be easily interrogated to understand the reasoning behind the model answer.





XXIX CYCLE

Mansoor Urf Manoo Parehar

Tema di ricerca:

Application of the Benders decomposition in Power Distribution system

Abstract:

Modern distribution networks require advanced optimization approaches to ensure safe and effective operation due to their growing complexity, which is enabled by the integration of renewable energy sources and the requirement for flexibility. In the current research, the Security-Constrained Optimal Power Flow (SCOPF) issue in distribution systems is solved using Benders decomposition. Benders decomposition provides an organized method for tackling the difficulties of big networks by breaking down the large-scale optimization issue into smaller, easier-to-manage subproblems and a master problem. From a current standpoint, the method offers adaptability in handling voltage and current violations, enabling efficient resource use in a range of network scenarios. It creates a flexible framework to incorporate new technologies and adjust to changing operational needs from a forward-looking perspective. The technique improves the viability of solving SCOPF in complex networks by separating the master problem which deals with high-level decisions from subproblems that deal with contingencies and detailed power flow calculations. The findings show that Benders decomposition is a strategic approach to guaranteeing flexibility, dependability, and sustainability in both present and future power systems, in addition to being a useful tool for managing extensive distribution networks.

Kainat Rizwan

Tema di Ricerca:

Blockchain and IoT solutions for managing innovative power systems

Abstract:





The integration of IoT devices, smart meters, Raspberry Pi, and blockchain technology is to transform the cutting-edge power systems which basically enables safe data transactions, well-organized management and more importantly dynamic energy monitoring. It is an adaptable approach which impact the flexibility of IoT-enabled devices such as Raspberry Pi which provides decentralized energy control and tracking, whereas the blockchain technology assure safe exchange of energy data, transparency, and Durability. Also the Applications integrate the smart energy meters that specify accurate analytics of consumption as well as energy management systems for auto-billing systems, industries and homes. Integration of Blockchain technology additionally facilitates peer-to-peer energy trading and also advances green energy adoption via assured smart contracts. These innovations just not only enhance working proficiency but also sustain energy goals by allowing users with data-driven insights and decentralized control over energy usage. This context confines notable potential for the development of innovative, secure, and intelligent power systems adapted to the demands of gradually interrelated world.

XXXVII CYCLE

Riccardo Trevisan

Tema di Ricerca:

Multidisciplinary Approaches and Tools for Enabling Energy Communities

Abstract:

The global energy transition is driven by the necessity to address climate change and promote sustainable development. The pivotal role of energy in sustaining modern societies and powering global economies is undergoing a transformation, with mounting pressure to reduce dependence on fossil fuels, which are responsible for considerable climate-altering emissions. In response to this challenge, a number of international initiatives have been put forth, including the UN 2030 Agenda for Sustainable Development and several non-binding Climate Agreements. These international agreements have urged states to commit to





reducing emissions, increasing the use of renewable energy sources, and adopting cleaner and more efficient technologies. In this global context, the European Union has assumed a pioneering role, proposing ambitious strategies and policies such as the European Green Deal, an action plan that aims to make the EU climate neutral by 2050. The initiatives aimed at achieving this ambitious goal are founded upon principles of equity and sustainability. At the core of these initiatives are Energy Communities, which represent an emerging model of energy production and management that enables citizens, businesses and local authorities to engage actively in resource management. Energy Communities have the potential to play a pivotal role in the decentralised management of the energy system and serve as catalyst initiatives for the direct and active involvement of local communities in the energy transition, thereby creating new opportunities for sustainable development.

