

The CIGRE Green Book, *Power System Dynamic Modelling and Analysis in Evolving Networks*, is a pivotal resource for engineers, researchers, and decision-makers navigating the energy transition in modern power systems. As the energy landscape shifts from conventional synchronous generators to renewable energy sources dominated by inverter-based resources (IBRs), this book draws on global expertise to provide a comprehensive guide to understanding and addressing the challenges and opportunities inherent in this transformation.

Why This Book Matters

The global push for a clean energy future demands more than just the integration of renewables. It requires a profound rethinking of how power systems are modelled, analysed, and managed. Traditional grids, primarily reliant on centralised synchronous generators, are giving way to inverter-driven systems with fundamentally different dynamic characteristics. This shift introduces complexities that cannot be tackled with conventional tools or methods alone.

This book addresses these critical gaps by offering:

- **A deep dive into the unique dynamics of modern power systems:** Unlike classical grids, today's systems exhibit phenomena like converter-driven instability, fast-response dynamics, and voltage oscillations. The book equips readers with the knowledge to understand and mitigate these emerging issues.
- **Practical and actionable guidance:** Drawing on global expertise and real-world case studies, it provides hands-on insights for engineers tasked with planning, operating, and stabilising these evolving networks.
- **A forward-looking perspective:** It highlights cutting-edge trends like artificial intelligence (AI)-driven modelling, hybrid simulation techniques, and the role of computational intelligence in power system operations.

What's New Compared to Conventional Power System Dynamic Books

The book distinguishes itself by focusing on the intersection of traditional power system engineering and the demands of the new energy paradigm. Here's what sets it apart:

1. **Inverter-Based Resources (IBRs):**
 - Explores how renewables like solar and wind, interfaced via inverters, impact grid stability and dynamics.
 - Details the control mechanisms of IBRs and their influence on grid behaviour, offering models and strategies to address their unique challenges.
2. **Modern Stability Frameworks:**
 - Introduces new forms of stability, such as converter-driven and resonance stability, reflecting the evolving nature of power systems.
 - Reexamines classical stability concepts to incorporate the effects of high-speed IBR controls and interactions.
3. **Advanced Modelling Tools:**
 - Discusses electromagnetic transient (EMT) simulation and hybrid simulations combining phasor-domain (PDT) and EMT techniques for greater accuracy.
 - Offers insights into real-time simulation, co-simulation, and optimisation techniques to handle the increasing complexity of modern grids.

4. Emerging Technologies:

- Showcases the role of AI and machine learning in grid operations, predictive analysis, and decision support.
- Explores the integration of distributed energy resources (DERs) like rooftop solar and battery systems into grid stability modelling and analysis.

5. Global Expertise:

- Compiled by leading engineers and researchers from around the world, the book reflects a wealth of practical and theoretical knowledge.
- Includes case studies from diverse systems, providing a truly international perspective on best practices and lessons learned.

Why Read This Book?

This Green Book is not just a technical manual; it is a roadmap for navigating the profound shifts in the energy sector. Engineers will find the tools and methodologies needed to manage modern grids effectively. Researchers will gain insights into emerging trends and unresolved challenges, sparking new directions for innovation. Policymakers and decision-makers will appreciate the book's holistic approach to ensuring grid reliability and resilience in the face of rapid change.

In an era where electricity systems are the backbone of decarbonisation and sustainable development, this book offers the clarity, guidance, and foresight needed to succeed in a complex, interconnected energy landscape. Whether you are shaping the future of renewable integration or ensuring the reliability of critical infrastructure, this book is an essential resource for understanding and mastering the dynamics of evolving power networks.